SOUTHERN VEGETABLE CROPS

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BY

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PREFACE

THE BASIC PRINCIPLES of vegetable growing are universal, but production practices vary materially in different sections of the country, depending upon economic and environmental factors. Without neglecting fundamentals, discussions on both principles and practices have been adapted to conditions which prevail in the southern part of the United States.

Section I, containing Chapters 1 to 13, was prepared by outstanding authorities and deals with fundamental principles. The information presented is generally applicable to all sections of the country. Section II, embracing Chapters 14 to 33, was written by leading southern horticulturists and discusses special crop production practices which generally prevail in the South.

The job-analysis plan, arranging production practices in order of seasonal sequence, has been employed in the vegetable chapters. The vocational idea prevails in spirit, arrangement, and content. The latest results of the agricultural experiment stations are incorporated and interpreted in the light of experience. The student or grower may adapt the general information to his own needs.

The purpose of this book is to give reliable, complete, co-ordinated, up-to-date information on the various phases of vegetable growing in the most systematic and convenient manner. It is designed as a text or reference book for vocational schools, junior colleges, and agricultural colleges; and as a handy manual for educational and commercial agricultural workers, growers, seedsmen, and others engaged in the industry.

The chapters are complete in themselves, but cross-references are made to avoid repetition and to supply additional information. An appropriate list of selected references appears at the end of each chapter. A brief glossary, including the most difficult words, precedes the index.

It is suggested that the reader, when using this book, study the chapters dealing with principles in connection with each production job as it is discussed. Instructors will find it helpful to assign pertinent parts of the general chapters on principles along with corresponding production practices in the crop chapters. Questions and problems have been omitted, as no set list will satisfy a large number of instructors or students under the existing widely different conditions.

The author-compiler wishes to acknowledge his indebtedness to a large number of teachers and research workers throughout the country.

The expert contributors who are listed in the acknowledgments and whose names appear at the beginning of their respective chapters, have made this publication possible. Their full co-operation makes the book authoritative, reliable, and completely up-to-date.

Credit is due the Bureau of Plant Industry, United States Department of Agriculture, and numerous farm journals and seed houses for photographs, charts, and related materials. The following books were used freely in determining arrangement and content: *Vegetable Crops*, by H. C. Thompson; *Vegetable Growing*, by J. E. Knott; and *Truck Crop Plants*, by H. A. Jones and J. T. Rosa. J. W. Park, Agricultural Economist, United States Department of Agriculture, kindly supplied data on acreage, value, shipping seasons, and carlot movements of vegetables; and E. B. Matthew, Arkansas State Director of Vocational Agriculture, reviewed the manuscript and approved the general arrangement and contents.

In addition, the following members of the University of Arkansas College of Agriculture have co-operated and assisted in various capacities: Dan T. Gray, Dean and Director; H. R. Rosen, Professor of Plant Pathology; Dwight Isely, Entomologist; Keith L. Holloway, Professor of Agricultural Education; Roy W. Roberts, Assistant Professor of Agricultural Education; Victor M. Watts, Associate Professor of Horticulture; J. R. Cooper, Head, Department of Horticulture and Forestry; L. M. Humphrey, Associate Agronomist; and Miss Jewelle McCulley, W. R. Stark, Jack Lincoln, R. S. Woodward, and C. R. Pinckley, associated with the University of Arkansas College of Agriculture, Fruit and Truck Branch Experiment Station.

The author-compiler is responsible for initiating, outlining, harmonizing, and generally editing and arranging the book; and for providing much of the illustrative and tabular information contained therein.

George W. Ware,
Author-Compiler.

Hope, Ark.
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INTRODUCTION TO SECTION I

PRINCIPLES

INTRODUCTION TO SECTION I

SECTION I, containing the first thirteen chapters, was prepared by selected authorities and deals with scientific facts and basic principles of vegetable growing. The object of this section is to stimulate interest and lay a foundation for the subsequent crop chapters.

Some of the chapters, such as VEGETABLE BREEDING AND IMPROVEMENT, CLASSIFICATION OF VEGETABLES, and PLANT GROWTH AND DEVELOPMENT, may not appeal to the practical person, but they give a more thorough understanding of vegetables, and help one to see and meet production problems in the most scientific manner.

Chapters 5 to 13 discuss general principles of the various operations involved in vegetable production, are arranged in seasonal sequence, and correspond with the job analysis treatment of crop chapters in Section II. The purpose of these discussions is not to give specific instructions in the production of any particular vegetable, but to present general information which will help one to understand and carry out the specific practices contained in the crop chapters, 14 to 33, of Section II.

The information in these chapters is generally applicable anywhere, but the contributors have constantly kept southern conditions in mind.

1

THE VEGETABLE INDUSTRY

G. W. Ware, Arkansas Experiment Station, Contributor

HISTORICAL. Vegetable growing is an old art which has been practiced for centuries in most civilized countries. The number of kinds of vegetables and their uses were rather limited, however, until comparatively recent times.

The American Colonial families were largely self-supporting, growing vegetables for a part of their food supply. With the industrial expansion which began about 1865, a marked change in vegetable growing took place. Concentrated populations became largely dependent upon special producers for their food supply, and as a result, commercial production of vegetables developed near the centers of population. This practice persisted from Civil War days until about 1910. Since 1910, vegetables have been produced commercially to a large extent in distant, specially adapted areas having favorable climate and advantages of labor supply and season. Vegetable production has increased more rapidly than any other type of crop production since 1920 as a result of improved methods of transportation, increased purchasing power, changing food habits, and the discovery of the importance of vegetables in the diet.

TYPES OF VEGETABLE GROWING. The several types of vegetable growing, some of which have been developed as a result of changing economic and social conditions, are briefly discussed here.

Home Gardening. In Colonial days, the home garden was the principal source of the fresh food supply for a large part of the population. Today, the importance of the city, suburban, and farm home gardens as a factor in the total production of vegetables cannot be overemphasized. This type of vegetable production is discussed fully in Chapter 33.

Market Gardening. As the cities became larger and more congested, residents of the outskirts increased their production and peddled the surplus to those living in the more fully occupied areas. This gave rise to the market-gardening industry, which has for its object the production of an assortment of vegetables for home market. Most

markets, particularly the large ones, are no longer local. The market gardeners, who originally grew a large variety of vegetables under intensive and considerably more expensive conditions, have been forced to change their types of farming to meet competition from specially adapted distant areas. Although market gardening is still expanding around the cities of the United States, motor-truck shipments from intermediate areas and rail shipments from special producing areas have resulted in increasing competition for this type of vegetable production.

Truck Growing. Increased demand for certain vegetables throughout the year, rapid transportation, and uniform refrigeration facilities led to the production of special crops in relatively large quantities for distant markets. In general, truck farming is more extensive and specialized than market gardening, and the location of truck-growing regions is determined primarily by climatic factors and soils favoring the culture of special crops. Since 1910, truck growing in the South has developed rapidly because of favorable climate, comparatively cheap land and labor, and excellent transportation facilities.

Canning Crop Production. Although the northern states and California lead in the production of canned vegetables, this industry is scattered over a large part of the United States and certain southern states can comparatively large quantities of vegetables. Arkansas, Maryland, and Tennessee, for example, rank high in the canning of tomatoes, peas, and sweet corn, respectively. Vegetables for canning are usually produced on a more extensive scale than those grown for market, and are generally grown in rotation with farm crops. Because of the necessity of low-cost production, the industry has sought areas of favorable climate and cheap labor. As a rule, canners contract for tonnage at a price with certain limitations on quality, a figure usually lower than the market price for fresh vegetables. Market demand for fresh vegetables, which can be supplied from the coastal states, has caused the canners serious concern; however, canned vegetables cannot as yet be economically replaced by such fresh vegetables.

Vegetable Forcing. Vegetable forcing, the production of vegetables out of their normal season, is accomplished by heat or protection from cold. Greenhouses are largely employed in the North, while cold frames are used to a considerable extent in the South.

Vegetable Seed Production. The production of vegetable seed is a rather specialized industry carried on in regions where climatic conditions are favorable to seed production and curing. While most vegetable

growers should not attempt to grow seed, they should know something of the problems involved in seed production and seed handling. These subjects are discussed in Chapters 4 and 5.

Scope and Importance

ACREAGE AND VALUE. The vegetable industry is now the most important division of horticulture; it is a major branch of agriculture; and in recent years has been referred to as a billion-dollar industry. Table 1 shows the importance of this industry as compared with other crops.

TABLE 1. ESTIMATED GROSS INCOME BY THE MAJOR CROP GROUPS [1]

	Millions of Dollars				Per Cent of All Crops in 1935
	1929	1932	1934	1935	
Vegetable [2]	1,130	609	702	775	23
Grains	1,297	450	542	700	21
Cotton	1,389	464	711	750	22
Fruits and nuts	707	325	464	500	15
All crops	5,434	2,288	3,077	3,400	100

[1] Crops and Markets, Report, U. S. Dept. Agr., as given in *Market Growers' Journal* No. 10, May 15, 1936.

[2] Includes potatoes, sweet potatoes, all vegetables for market and manufacture, and vegetables grown in farm gardens.

The South has played a major part in expanding the vegetable industry by supplying northern markets with many out-of-season vegetables. Table 2 shows the relative importance of the southern states in vegetable production, as compared with some of the other leading states. Table 3 ranks the different commodities according to their importance.

REGIONS. For the purpose of this text, 13 states are arbitrarily considered in the South. In descending order of total vegetable acreage, they include, Texas, Florida, Georgia, Virginia, South Carolina, North Carolina, Arkansas, Mississippi, Tennessee, Louisiana, Alabama, Kentucky, and Oklahoma. According to Blair and Thompson, three of the seven important truck-growing regions of the United States are in the South, namely, (1) Atlantic coast states, (2) Gulf states, and (3) interior southern states.

TABLE 2. ESTIMATED ACREAGE AND FARM VALUE OF SOME MARKET AND CANNING VEGETABLE CROPS COMPARING SOUTHERN STATES AND OTHER LEADING STATES, 1929–1935 AVERAGE [1]

STATES	MARKET ACREAGE	CANNING ACREAGE	TOTAL ACREAGE	MARKET FARM VALUE, 1,000 DOLLARS	CANNING FARM VALUE, 1,000 DOLLARS	TOTAL FARM VALUE, 1,000 DOLLARS
Southern						
Texas	183,797	4,201	187,998	14,116	95	14,211
Florida	138,483	1,971	140,454	21,000	98	21,098
Georgia	80,621	8,371	88,992	2,148	366	2,514
Virginia	31,337	29,476	60,813	3,077	1,216	3,293
South Carolina	50,463	1,944	52,407	3,473	76	3,549
North Carolina	32,914	1,821	34,735	1,750	102	1,852
Arkansas	12,720	19,549	32,269	610	498	1,108
Mississippi	23,346	7,066	30,412	2,621	221	2,842
Tennessee	10,941	16,376	27,317	1,342	513	1,855
Louisiana	23,630	2,593	26,223	1,704	88	1,792
Alabama	10,986	1,756	12,742	555	72	627
Kentucky	2,680	6,836	9,516	233	188	421
Oklahoma	5,173	1,906	7,079	204	40	244
Total for 13 Southern States	607,091	103,866	710,952	52,833	3,573	56,406
Other States						
California	337,600	103,556	441,156	57,765	7,858	65,623
Wisconsin	15,341	141,741	157,082	1,048	5,521	6,569
Indiana	23,653	127,233	150,886	2,169	4,350	6,519
New York	67,510	83,673	150,183	10,206	4,292	14,498
Maryland	26,464	108,993	135,457	2,322	4,317	6,639
New Jersey	95,104	35,547	130,651	10,785	3,017	13,802
Total for United States	1,405,886	1,137,971	2,543,857	170,431	47,573	218,004

[1] Crops grown for market: Artichokes, asparagus, lima beans, snap beans, beets, cabbage, cantaloupes, carrots, cauliflower, celery, sweet corn, cucumbers, eggplant, kale, lettuce, onions, green peppers, spinach, tomatoes, and watermelons. Those grown for canning and manufacture: Asparagus, lima beans, snap beans, beets, cabbage (kraut), sweet corn, cucumbers (pickles), green peas, pimientos, spinach, and tomatoes. (Irish potatoes, sweet potatoes, farm gardens, strawberries, and the less important vegetables are not included.)

(Statistics prepared from mimeograph reports supplied by the Crop Reporting Board of the Bureau of Agricultural Economics, U. S. Dept. Agr.)

TABLE 3. ESTIMATED COMMERCIAL ACREAGE, YIELD, PRODUCTION, UNIT PRICE, AND VALUE OF 24 VEGETABLE CROPS IN THE UNITED STATES (BOTH MARKET AND CANNING) 1929–1935 AVERAGE

CROP	ACREAGE	UNIT OF PRODUCTION (POUNDS)	YIELD PER ACRE IN UNITS	PRODUCTION[1] 1,000 UNITS	UNIT PRICE (DOLLARS)	FARM VALUE, 1,000 DOLLARS
Artichoke	7,797	Box, 40	114.00	887	1.63	1,449
Asparagus	60,990	Crate, 24	77.00	4,718	1.69	7,984
Asparagus *	44,531	Ton, 2,000	1.24	55	70.21	3,882
Bean, lima	10,743	Bushel, 32	60.00	640	1.33	853
Bean, lima *	24,260	Ton, 2,000	0.54	13	69.35	912
Bean, snap	122,151	Bushel, 30	89.00	10,880	1.13	11,874
Bean, snap *	51,771	Ton, 2,000	1.38	72	50.23	3,601
Beet	10,473	Bushel, 52	178.00	19	0.51	921
Beet *	6,310	Ton, 2,000	5.77	36	12.45	453
Cabbage	126,744	Ton, 2,000	6.60	83,620	14.81	12,338
Cabbage *	20,421	Ton, 2,000	7.85	16,037	7.13	1,144
Cantaloupe	118,566	Crate, 60	128.00	15,143	1.04	15,060
Carrot	31,819	Bushel, 50	366.00	11,633	0.54	6,075
Cauliflower	28,971	Crate, 39	240.00	6,939	0.70	4,882
Celery	33,096	⅘ Crate, 90	274.00	9,082	1.50	13,502
Corn	23,642	1,000 Ears, 780	4.65	110	11.80	1,299
Corn *	306,617	Ton, 2,000	2.00	61,250	10.48	6,416
Cucumber	45,644	Bushel, 48	92.00	4,187	0.99	3,840
Cucumber *	77,990	Bushel, 48	61.00	4,729	0.64	3,030
Irish potato, early	293,000	Bushel, 60	132.00	38,622	0.81	31,114
Eggplant	3,610	Bushel, 33	216.00	781	0.78	613
Kale	1,800	Bushel, 18	358.00	645	0.34	220
Lettuce	157,306	Crate, 75	121.00	19,060	1.48	28,106
Onion	86,543	Sack, 100	155.00	13,457	1.11	14,713
Pea	94,967	Bushel, 30	75.00	7,151	1.29	9,170
Pea *	242,400	Ton, 2,000	0.75	18,286	52.25	9,554
Pepper	16,730	Bushel, 25	224.00	3,743	0.80	2,979
Pimiento *	8,926	Ton, 2,000	1.65	1,477	32.90	486
Spinach	52,973	Bushel, 18	227.00	12,047	0.45	5,243
Spinach *	11,786	Ton, 2,000	3.86	46	14.00	641
Sweet potato	732,143	Bushel, 50	89.00	65,071	0.86	55,724
Tomato	157,244	Bushel, 53	111.00	17,456	1.31	22,512
Tomato *	343,833	Ton, 2,000	4.00	137,573	12.69	17,454
Watermelon	214,076	Melon, 25	294.00	62,971	0.11	6,799
Market Total	2,431,828					257,270
Canning Total	1,137,971					47,573
Grand Total	3,569,799					304,843[2]

* Indicates canning crops; those not marked represent market crops.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Late Irish potatoes, the less important vegetables, and farm gardens are not listed or included.

(Statistics prepared from mimeograph reports supplied by the Crop Reporting Board of the Bureau of Agricultural Economics, U. S. Dept. Agr.)

Physical Factors and Requirements

CLIMATIC REQUIREMENTS. Climate is the most important limiting factor in the commercial production of vegetables at long distances from market. The principal truck-growing regions of the country have developed as result of climatic conditions favorable to certain crops during the season in which they are grown. Transportation is generally available to all regions of the country, making it possible to select one which is naturally suited to the production of a certain vegetable. Most of the important truck-growing regions of the South and west coast have developed as a result of favorable climatic conditions, despite high transportation costs.

According to Thompson, "Many regions are important not because they can produce better and larger crops than other regions, but because they can produce them at a time when others cannot grow them. For example, cabbage, celery, onions, peas, and many other crops are produced more cheaply in the North than in the South, but the South can produce them when the North cannot. The southern states could not compete successfully with New York and other northern states in the production of cabbage, celery, onions, and many other crops if they were produced in the two regions at the same time. Lettuce production during the summer has developed along the Pacific coast and at high altitudes in the West where the temperature is relatively low, and water is available for irrigation. In spite of high freight costs, these regions now control the lettuce market in the large cities of the East."

The most important climatic factors are (1) temperature, (2) atmospheric humidity, and (3) rainfall. Temperature is generally the most important factor in determining the localization of truck-growing areas. Atmospheric humidity also is very important for some crops. For example, cantaloupes are grown extensively in the Southwest where temperatures are high and humidity low. Rainfall is very important for the production of all vegetable crops, where moisture requirements are not maintained by irrigation.

SOIL REQUIREMENTS. Soil character is an important factor in determining specific locations in regions climatically suited to vegetable growing. Since soil requirements vary somewhat for different kinds of vegetables, the selection of the type of soil which is best suited to the crop or crops is important. Soil preference for different crops is discussed generally in Chapter 6, and in the chapters on specific crops.

TRANSPORTATION REQUIREMENTS. Good transportation facilities are essential to success in truck growing, since the produce is transported considerable distances and must reach the market in good condition. The earliest development of truck growing in the South was confined to the areas that had water transportation to the cities of the East. The introduction of commercial refrigeration in 1886 and the subsequent development of the refrigerator car opened the way for expansion. Express service, improved farm-to-market roads, and motor trucks have contributed materially in making the South a great truck-growing region. Further improvement of roads, fast refrigerator motor trucks, improved rail transportation at less cost, and refrigerator boats make the South potentially greater, limited only by its ability to compete with other regions.

Other Factors and Requirements

THE PERSONAL FACTOR. Successful truck farming depends to a considerable extent on the aptitude of the individual producer. Some farmers adapt themselves easily to truck growing, while others are slow to adjust themselves to such a type of farming. For example, many farmers do not like to produce vegetables, and they have little patience with the exacting requirements of intensive vegetable production, preferring to grow a crop that has a wider planting and harvesting range.

ECONOMIC DIFFERENCE BETWEEN VEGETABLE AND FRUIT GROWING. Observers generally appreciate the fact that the requirements of horticultural crops are considerably different from those of field crops or livestock farming. There are also several essential differences between the vegetable and fruit industries which should be called to the attention of the student.

(1) Truck farming does not ordinarily involve a long-time investment as does an orchard, and the truck grower is not bound to grow the same crop each year.

(2) Many trucking areas, particularly those in the process of development and exploitation, lack the stability of the orchard district which was methodically developed over a period of years. Getting into fruit growing is a slow process, and getting out may be even slower.

(3) Since the problem of financing a truck crop is largely an annual one, tenants can be used, whereas few orchardists are willing to turn over their growing or bearing trees to temporary operators.

(4) Co-operative effort and organization are more difficult among truck growers than fruit growers. Orchardists have years for making permanent plans and perfecting an organization, whereas vegetable "deals" come and go, and the grower is often disappointed.

(5) Truck farming is often promoted and financed by the dealer or commission man, and production is determined accordingly. Fruit growers are usually more independent and secure long-term credit at low interest rates.

(6) The acreage and resulting production of truck crops is very flexible, responding easily to promotion, enthusiasm, or price outlook, whereas the fruit industry is slowly adjustable.

(7) Truck crops are often grown by farmers with little or no experience, and as a result, frequent failures occur. If the fruit grower develops his own orchard, he is likely to be generally acquainted with the industry by the time his trees start bearing.

From the contrasts mentioned, one may infer that the vegetable industry is generally unstable and comparatively undesirable. This is not the case, necessarily, as many permanent well-organized vegetable-producing areas have been established throughout the South.

SOURCES OF INFORMATION. During the formative period of the truck-growing industry in the South, producers relied largely on commercial agencies for information on varieties and production methods. As truck growing became more stabilized in specially adapted areas, considerable improvement resulted from trial and error in establishing more desirable varieties and cultural practices. Truck growers, seed companies, and handling agencies have been alert to make improvements as problems and competition increased. As the industry expanded, more complex problems of production and marketing arose. Producers did not have the time, money, patience, facilities, or training to solve many of them. The experiment stations have worked out many of the truck growers' problems of pest control, nutrition, processing, marketing, and other economic factors. With restricted resources, it has been impossible for the experiment stations to answer fully, specific questions as they arose in a fast-developing, ever-changing industry. Realizing that production problems vary considerably from section to section, most of the southern states have established branch stations and outlying test fields in the areas of production (Fig. 1). With the improvement of research personnel and working facilities during recent years, the experiment stations have made many valuable findings on varieties,

University of Ark Fruit and Truck Branch Exp Sta

FIG. 1. The experiment station systems of most of the southern states include branch stations in the areas of special production. Suitable working facilities and buildings are provided to take care of the special experimental requirements.

fertilizers, pest control, and general cultural and marketing practices for the different crops.

The present outlook indicates that the vegetable industry should continue to be an important and comparatively profitable branch of agriculture. With increasing competition from many other sections, the South will profit by reducing the cost of production and marketing. This can be accomplished by growing improved varieties, using fertilizers judiciously, practicing effective pest-control measures, managing labor more efficiently, utilizing labor-saving devices where possible, and by adopting improved marketing methods.

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2

CLASSIFICATION OF VEGETABLES

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Knowledge of the relationship of vegetable crop plants is important to the student, because the habits of growth and susceptibility to injury by disease and insect pests are likely to be similar for members of the same species and genus, or even of the same family in some cases. For the reader of this book, it is important that these relationships be learned at this time, because the crops to be considered later will be discussed individually rather than as groups of closely related crops. Economy of effort will be effected if the student understands and appreciates the relations of the crops to each other.

A botanical classification alone, however, does not completely satisfy the needs of the student interested in the production of vegetables. He needs to have some orderly arrangement in mind which will help him relate one crop to another in respect to their cultural requirements and uses as human food.

The members of the same botanical family may be grown for different plant parts. For example, some members of the *Umbelliferae* are grown for their foliage, others for their fruits, and still others for their fleshy root parts. The following classification has been adapted from Bailey's *Principles of Vegetable Gardening*. By comparing the three lists, one with another, the student may see at a glance which crops belong to the same botanical family. Even though some of the vegetable crops in these lists are uncommon, they have been included, in order to acquaint the student with the general relationships and the uses for which these little-known vegetables may be grown.

BOTANICAL FAMILIES AND CROP USE

1. Vegetables of Which the Leaves, Flower Parts, or Stems Are Used.

Liliaceae. Lily Family.
- Asparagus, *Asparagus officinalis* var. *altilis*.
- Chive, chives, *Allium Schoenoprasum*.

Polygonaceae. Buckwheat Family.
- Rhubarb, *Rheum Rhaponticum*.
- Sorrel, *Rumex Acetosa*.
- Spinach dock, *Rumex Patientia*.

Chenopodiaceae. Goosefoot Family.
Beet, *Beta vulgaris.*
Chard, *Beta vulgaris* var. *cicla.*
Orach, *Atriplex hortensis.*
Spinach (prickly-seeded), *Spinacia oleracea.*
Spinach (round-seeded), *Spinacia oleracea* var. *inermis.*

Aizoaceae. Carpetweed Family.
New Zealand spinach, *Tetragonia expansa.*

Cruciferae. Mustard Family.
Brussels sprouts, *Brassica oleracea* var. *gemmifera.*
Cabbage, *Brassica oleracea* var. *capitata.*
Cauliflower, *Brassica oleracea* var. *botrytis.*
Collard, *Brassica oleracea* var. *acephala.*
Cress, *Lepidium sativum.*
Kale, Borecole, *Brassica oleracea* var. *acephala.*
Kohl-rabi, *Brassica caulorapa.*
Mustard, leaf, *Brassica juncea.*
Mustard, Southern Curled, *Brassica juncea* var. *crispifolia.*
Pak-choi, Chinese cabbage, *Brassica chinensis.*
Pe-tsai, Chinese cabbage, *Brassica pekinensis.*
Sea-kale, *Crambe maritima.*
Sprouting broccoli, *Brassica oleracea* var. *italica.*
Turnip, Seven Top, *Brassica Rapa* var. *septiceps.*
Upland cress, *Barbarea verna* (*praecox*).
Watercress, *Roripa Nasturtium aquaticum.*

Araliaceae. Ginseng Family.
Udo, *Aralia cordata.*

Umbelliferae. Parsley Family.
Celery, *Apium graveolens* var. *dulce.*
Chervil, *Anthriscus Cerefolium.*
Fennel, *Foeniculum vulgare.*
Parsley, *Petroselinum hortense.*

Valerianaceae. Valerian Family.
Corn-salad, fetticus, *Valerianella Locusta* var. *olitoria.*

Compositae. Composite or Sunflower Family.
Artichoke, *Cynara Scolymus.*
Cardoon, *Cynara Cardunculus.*
Chicory, witloof, *Cichorium Intybus.*
Dandelion, *Taraxacum officinale.*
Endive, *Cichorium Endivia.*
Lettuce, *Lactuca sativa.*

2. Vegetables of Which the Underground Parts Are Used.

Liliaceae. Lily Family.
Garlic, *Allium sativum.*
Leek, *Allium Porrum.*
Onion, *Allium Cepa.*
Shallot, *Allium ascalonicum.*
Welsh onion, *Allium fistulosum.*

Dioscoreaceae. Yam Family.
Yam (true), *Dioscorea Batatas.*

Chenopodiaceae. Goosefoot Family.
Beet, *Beta vulgaris.*

Cruciferae. Mustard Family.
Horse-radish, *Armoracia rusticana.*
Radish, *Raphanus sativus.*
Rutabaga, *Brassica Napobrassica.*
Turnip, *Brassica Rapa.*

Umbelliferae. Parsley Family.
Carrot, *Daucus Carota* var. *sativa.*
Celeriac, *Apium graveolens* var. *rapaceum.*
Hamburg parsley, *Petroselinum hortense* var. *radicosum.*
Parsnip, *Pastinaca sativa.*

Convolvulaceae. Morning-glory Family.
Sweet potato, yam (erroneously), *Ipomoea Batatas.*

Solanaceae. Nightshade Family.
Potato, *Solanum tuberosum.*

Compositae. Composite or Sunflower Family.
Black salsify, *Scorzonera hispanica.*
Chicory, *Cichorium Intybus.*
Girasole (Jerusalem artichoke), *Helianthus tuberosus.*
Salsify, *Tragopogon porrifolius.*
Spanish salsify, *Scolymus hispanicus.*

3. Vegetables of Which the Fruits or Seeds Are Used.

Gramineae. Grass Family.
- Sweet corn, *Zea Mays* var. *rugosa.*

Leguminosae. Pulse or Pea Family.
- Asparagus or Yardlong bean, *Vigna sesquipedalis.*
- Broad bean, *Vicia Faba.*
- Bush bean, *Phaseolus vulgaris* var. *humilis.*
- Bush lima bean, *Phaseolus limensis* var. *limenanus.*
- Cowpea, *Vigna sinensis.*
- Edible podded pea, *Pisum sativum* var. *macrocarpon.*
- Kidney bean, *Phaseolus vulgaris.*
- Lima bean, *Phaseolus limensis.*
- Pea (English pea), *Pisum sativum.*
- Peanut (underground fruits), *Arachis hypogaea.*
- Scarlet runner bean, *Phaseolus coccineus.*
- Sieva bean, *Phaseolus lunatus.*
- Soybean, *Glycine Max.*
- White Dutch runner bean, *Phaseolus coccineus* var. *albus.*

Malvaceae. Mallow Family.
- Okra (gumbo), *Hibiscus esculentus.*

Umbelliferae. Parsley Family.
- Caraway, *Carum Carvi.*
- Dill, *Anethum graveolens.*

Solanaceae. Nightshade Family.
- Eggplant, *Solanum Melongena* var. *esculentum.*
- Ground cherry (Husk tomato), *Physalis pubescens.*
- Pepper (Bell or sweet), *Capsicum frutescens* var. *grossum.*
- Tomato, *Lycopersicon esculentum* var. *commune.*

Martyniaceae. Martynia Family.
- Martynia, *Probescidea louisiana.*

Cucurbitaceae. Gourd or Melon Family.
- Bush pumpkin, *Cucurbita Pepo* var. *Melopepo.*
- Chayote, *Sechium edule.*
- Cucumber, *Cucumis sativus.*
- Cushaw, *Cucurbita moschata.*
- Gherkin, *Cucumis Anguria.*
- Muskmelon (cantaloupe), *Cucumis Melo.*
- Pumpkin, *Cucurbita Pepo.*
- Squash, *Cucurbita maxima.*
- Watermelon, *Citrullus vulgaris.*
- Winter melon (cassaba), *Cucumis Melo* var. *inodorus.*

All plants in the families given in the above classification are dicotyledonous, having two seed leaves, except for those of the Grass and Lily families which are monocotyledonous, with one seed-leaf.

Adaptation to Heat and Cold

Vegetables differ materially in their adaptation to high and low temperatures. They fall naturally into two groups. The first group includes those vegetables which grow best under relatively cool conditions, and the second group includes those which can withstand high temperatures.

The plants that will grow successfully in hot weather are so tender that their growth is checked when the air is cool and death results quickly if they are frosted. The tender crops are a little less susceptible to injury from cool weather than are the very tender crops. There is considerable variation in the soil temperature necessary for seed germination within the tender and very tender groups.

The cool-season crops, on the other hand, can withstand light frosts. Some of them can even endure winter freezing, notably asparagus and rhubarb. Thus, it is this group of crops that one plants earliest in the spring and late in the season for fall and winter harvest. These are the hardy and half-hardy vegetables listed in Table 4. The separation

TABLE 4. GENERAL CLASSIFICATION BY RESISTANCE TO SPRING FROSTS

Cool-Season Crops		Warm-Season Crops	
Hardy	Half hardy	Tender	Very tender
Asparagus Brussels sprouts Cabbage Horse-radish Kale Kohl-rabi Leek Mustard Onion Parsley Pea Radish Rhubarb Rutabaga Spinach Sprouting broccoli Turnip	Beet Carrot Cauliflower Celery Chard Chinese cabbage Endive Irish potato Lettuce Parsnip Salsify	New Zealand spinach Snap bean Sweet corn Tomato	Cucumber Cantaloupe (muskmelon) Eggplant Lima bean Okra Pepper Pumpkin Squash Sweet potato Watermelon

into hardy and half-hardy crops is based primarily on the ability of the seed to germinate at low soil temperatures and of the young plants to withstand frosts. This grouping does not necessarily apply to the full-grown plants. Carrot, beet, parsnip, and salsify can remain in the ground late in the fall because of the protection given the root by the soil. In this sense they are more hardy than some of the so-called hardy crops.

While the cool-season crops are unable to withstand the high summer temperatures of the South, some of them are affected also by prolonged exposure to relatively cool temperatures. The biennials, celery, beet, cabbage, and carrot, may produce seedstalks instead of edible growth the first year if, during the winter months, growing plants are subjected to an average temperature of 50° F. or lower for several weeks. The spring and fall planting dates of different vegetables are given by zones in Tables 11 and 12 respectively.

Season of Growth of Vegetables

Climatic conditions in the South and, therefore, the seasons of the year in which successful growth of certain vegetables can be obtained, are different from those in other sections of the country where vegetable crops are produced commercially. Moreover, the problem is complicated in the South, since growers in central and southern Florida and in the lower Rio Grande Valley are able to grow certain vegetables during the winter months, which is impossible in more northern regions.

A system of listing vegetables according to the time of year in which they may be grown is an advantage in planning rotations and making cropping plans. This information will supplement that given in Chapters 8 and 33. What has already been learned with regard to the ability of the crops to grow in cool or warm weather is of value in developing the following classification. The interpretation to be placed on this scheme is that the vegetables in the first group (the crops adapted to winter and spring growth) may be planted in the winter months, if climatic conditions permit, for harvest during late winter and spring. Similarly, the next group includes the cool-season crops which are planted in the spring for harvest in late spring and early summer and, also, the warm-season crops which are started in the spring for summer harvest.

1. WINTER AND SPRING VEGETABLES. Hardy vegetables which grow best under cool conditions and which do not thrive during the hottest part of the summer in most parts of the South are cabbage, carrot, cauliflower, Chinese cabbage, kale, Irish potato, lettuce, mustard, onion, parsnip, pea (English pea), radish, spinach, and turnip.

2. SPRING AND SUMMER VEGETABLES. The vegetables marked with an asterisk (*) are cool-season crops and should be planted early enough to complete their growth before the arrival of hot weather. Vegetables falling in this general group include beans (bush, snap, and lima), beans (pole snap and pole lima), beet*, cabbage*, cantaloupe, carrot*, celery*, collard, cucumber, eggplant, Irish potato, kale*, kohlrabi*, leek, lettuce*, mustard*, New Zealand spinach, okra, onion*, parsley*, parsnip*, pepper, salsify*, spinach*, squash, sweet corn, sweet potato, Swiss chard, tomato, turnip*, and watermelon.

3. SUMMER AND FALL VEGETABLES. The vegetables marked with an asterisk (*) are cool-season crops which are sensitive to high temperatures and should be planted late in the summer. In the case of those vegetables for which plants are grown in the seedbed, the plants

should not be set in the field until late summer. The vegetables belonging to the summer and fall group are beans (bush snap and lima), beet*, Brussels sprouts*, cabbage*, carrot*, cauliflower*, Irish potato, onion*, parsley*, parsnip*, pea (English pea)*, pepper, celery*, Chinese cabbage*, collard, endive, kale*, kohl-rabi, lettuce*, mustard*, potato (sweet), rutabaga, spinach*, Swiss chard, tomato, and turnip.

4. FALL AND WINTER VEGETABLES. Cool-season crops which may be planted in the fall for harvest in the fall or winter, where climatic conditions are such that severe freezes are uncommon, include beet, Brussels sprouts, cabbage, cauliflower, carrot, celery, Chinese cabbage, endive, kale, kohl-rabi, leek, lettuce, mustard, onion, parsley, parsnip, pea (English pea), radish, rutabaga, salsify, spinach, Swiss chard, and turnip.

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PLANT GROWTH AND DEVELOPMENT

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Before discussing the principles and practices involved in vegetable production, a brief review of plant growth and development is desirable. The subject is treated in a general and practical manner.

The plant consists of groups of cells which are considered the structural units of a plant in much the same way as bricks are considered the structural units of a building. In mature plants, cells vary in size, shape, and arrangement. Under microscopic examination, the cells at the root and shoot tips of a bean plant, for example, are found to be small and box-shaped. In the stem, some cells are large, roundish or angular, and possess thick walls; while others are fiberlike and still others are like miniature pipes.

When plants are growing, these cells at the tips divide, adding new cells to the plant, which increases its length. If the regions just back of the dividing cells are examined, the cells are found to be larger than those at the tip. This region is called the region of enlargement, and the increase in size also adds length to the plant.

Examination of the region back of the zone of enlargement shows that marked changes have taken place. Some cells, known as the water-conducting cells, have lost their cross walls and have formed a series of pipes. Other cells have become fiberlike, and have formed a series of strands throughout the plant body and serve as a framework of the plant in much the same way as steel girders serve as a framework of a building. Those cells on the outside have become toothed and flanged and have deposited a coat of wax on the outside. Others may have large quantities of starch stored in them.

Students of plant life have found that the growth and development of plants consist essentially of three phases: (1) The making of cells, (2) the enlargement of cells, and (3) the maturation of cells. A separate discussion on each of these follows.

Making of Cells

WHERE CELLS DIVIDE. As stated, cell division occurs at the root and shoot tips (Fig. 2). Essentially, cell division has to do with

the making of new cell walls and new protoplasm. The cell walls consist of cellulose and pectin, a sticky substance which binds the cellulose fibers together. Protoplasm is the living substance of plants and consists largely of water, sugars, fats, and proteins. Cell division depends primarily on (1) the manufacture of sugars and proteins, (2) the translocation of the sugars and proteins to the growing points, and (3) the liberation of energy.

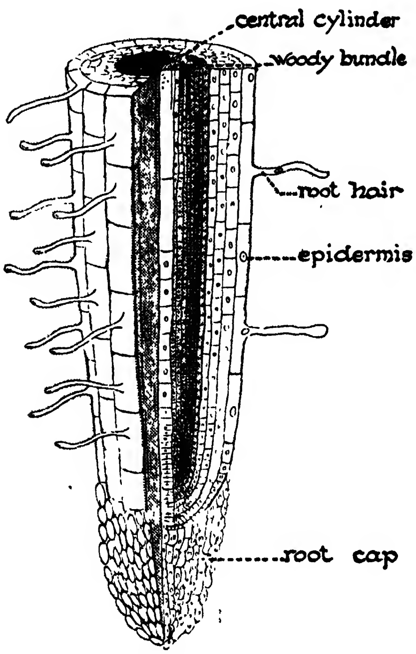

FIG. 2. Diagram of root tip showing growing point. Note small box-like cells at the tips.

HOW AND WHERE THE SUGARS AND PROTEINS ARE MADE. Sugars are manufactured in the green cells of plants. Carbon dioxide from the air and water from the soil combine with the aid of sunlight and chlorophyll (the green pigment of plants) to make the sugars. The first sugar formed is relatively simple in construction. It may remain unchanged or it may be changed into a great variety of more complex compounds, chief of which are sucrose, starch, and cellulose. The simple sugars supply living cells with energy. The cellulose is used to make all cell walls, while starch is stored and later changed back to sugar and used by the plant. Certain plants store large quantities of starch and are used for food, notable examples being Irish and sweet potatoes.

FACTORS AFFECTING SUGAR MANUFACTURE. The manufacture of sugar depends on a large number of factors. Most important are (1) leaf area, (2) amount of chlorophyll per unit area of leaf surface, (3) certain minerals in the soil solution, (4) activity of the stomata (small pores in green tissue which allow carbon dioxide, oxygen, and water vapor to pass through), and (5) sunlight.

Generally, the greater the leaf area the greater is the opportunity for the manufacture of sugar. In other words a plant with a large leaf area will make more sugar in a given time than a plant with a small leaf area. Since the root tips require sugars for the making of new cells, plants

with a larger leaf area will have a larger root system than those with a small leaf area. Cell division at both the root and shoot tips is dependent on the supply of sugars made in the leaves. Hence the growth of the roots and the stems is dependent on the health and abundance of the leaves.

Scientists have shown that dark green leaves usually contain more chlorophyll per unit of leaf area than light green leaves. They also have shown that these leaves make more sugar in a given time; consequently, the health of the foliage, as indicated by its color, is very important from the standpoint of sugar manufacture, cell division, and growth.

MINERALS NECESSARY FOR SUGAR MANUFACTURE. Certain minerals, potassium, magnesium, manganese, and iron, are necessary for the making of sugars. When these minerals are absent from the soil solution, the leaves become yellow and chlorotic and do not make sugars. For example, it has been found that snap beans growing in soil lacking in available magnesium, manganese, and iron contain less sugars and produce lower yields than those growing in soil which contains these minerals.

INFLUENCE OF THE STOMATA. The stomata are small openings or pores in the leaves and stems which allow carbon dioxide and oxygen to enter and leave the plant (Fig. 3). Since carbon dioxide

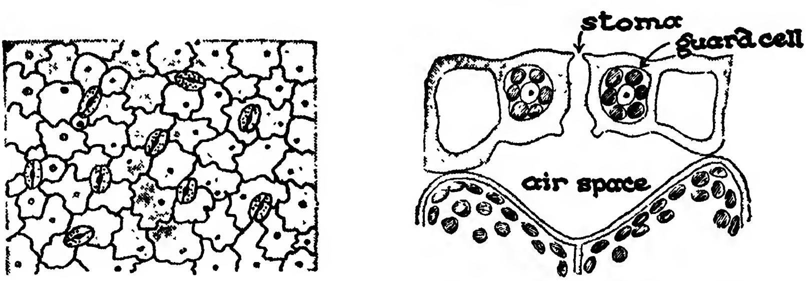

FIG. 3. Stomatal apparatus of a leaf. Note that the guard cells contain chloroplasts. The left-hand diagram shows the under surface of a leaf.

is essential for the manufacture of sugar, when the stomata are completely closed, the plant is not making sugars. Under certain conditions, the stomata are closed; while under other conditions, they are open. Light and the water supply are the most important factors affecting the opening of the stomata. With most plants, the stomata are open in the day and closed at night provided the plant receives adequate amounts of water. When the water supply within the plant begins to diminish, the stomata close.

HOW AND WHERE PROTEINS ARE MADE. Proteins are made in the leaves and roots. Their manufacture depends on sugar manufacture and on the absorption of minerals from the soil. Sugars and nitrogen are used in the manufacture of all proteins, and some require phosphorus, potash, and sulfur also. Since nitrogen is necessary for the manufacture of all proteins and since protoplasm is largely made up of proteins, the nitrogen supply in the soil is particularly important.

HOW THE NITROGEN SUPPLY IS MAINTAINED. The nitrogen supply depends on the activity of microorganisms in the soil. These microorganisms are minute plants which are influenced by their surroundings in much the same way as are the higher plants. Most important factors affecting the activity of these nitrogen-forming bacteria are (1) the amount of organic matter in the soil, (2) the temperature, (3) the water supply, (4) the oxygen supply, and (5) the acidity of the soil.

Microorganisms live on organic matter in the soil. This organic matter is food from which they obtain energy, therefore the greater the amount of organic matter in the soil the greater is the food supply. A prime reason for the growing of cover crops and the applying of manure is to supply these desirable soil organisms with their necessary food supply.

As a rule, the higher the temperature (between 32° F. and 86° F.) the greater is the activity of soil microorganisms. Obviously, bacterial activity will be greater in summer than in winter. Because bacterial activity is low during cold weather, growers of truck crops in winter and early spring often apply as side dressings readily available forms of nitrogen.

Nitrogen-fixing organisms require plenty of fresh air, which supplies the necessary oxygen for the vital process of respiration. If the soil is poorly drained or water-logged, the air is displaced and the bacteria are affected accordingly. The acidity of the soil is also important. Investigations have shown that bacteria work best when the soil is slightly acid.

HOW THE FOODS ARE TRANSLOCATED. In order for cells to divide, the food substances, sugars and proteins, of which they are formed, must be transported from the place where they are made to the place where they are used. Translocation of the foods depends on the water supply; in fact the water stream within the plant is really its transportation medium. Two rather distinct streams exist in plants,

(1) a downward-moving stream and (2) an upward-moving stream. The downward-moving stream carries sugars and other foods, always in solution, to various growing points in the stem and roots and to the storage regions. The upward-moving stream carries water and minerals obtained from the soil solution.

RELATIONSHIP BETWEEN ENERGY, WORK, AND GROWTH. Growth is an expression of work. When plant cells are growing, they are dividing and hence a growing plant is working against the pressure of the atmosphere. In order to grow, the cells must have a source of energy. This energy is derived from simple sugars, and is obtained through the process of respiration which is exactly the same way that animals obtain energy. Respiration is exactly the opposite of sugar manufacture or photosynthesis. In respiration, the simple sugars decompose to carbon dioxide and water with the liberation of energy. In photosynthesis, carbon dioxide and water combine to form simple sugars with the fixation of energy. By respiration, plants obtain energy for their vital needs.

The processes of photosynthesis and respiration from the standpoint of (1) time of occurrence, (2) seat of operation, and (3) energy relations are contrasted below:

PHOTOSYNTHESIS	RESPIRATION
1. Occurs in green cells only	1. Occurs in all living cells
2. Occurs during day only	2. Occurs both day and night
3. Fixes energy	3. Liberates energy

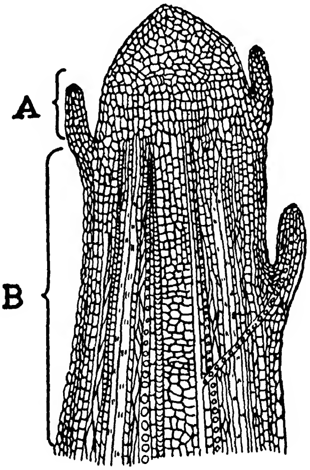

FIG. 4. Diagram of longitudinal section of a growing tip of stem showing (A) region of cell enlargement and (B) region of cell maturation.

Enlarging of Cells

As stated before, the regions just back of a growing point have cells which are larger than those at the tips (Fig. 4). This increase in size is dependent largely on the water supply in the plant and on the stretching ability of the cell wall. For example, if the amount of water going into a single cell is the same as the amount going out for a given length of time, the cell does not materially change in size. However, if the amount going in is somewhat greater than the amount going out,

the cell increases in size. Consequently, abundant supplies of water are necessary for cell enlargement. In other words, the stretching of the cell walls increases cell size and growth.

The amount of water going into a plant depends on the concentration of sugars and minerals in the cell sap and on the elasticity of the cell wall. In general, the greater the concentration of sugars, the greater will be the intake of water. The amount of water going out of a plant depends on the forces of evaporation. As a rule, the greater the evaporation the greater will be the outgo, provided abundant water is available. The effect of evaporation on plant growth will be fully discussed later.

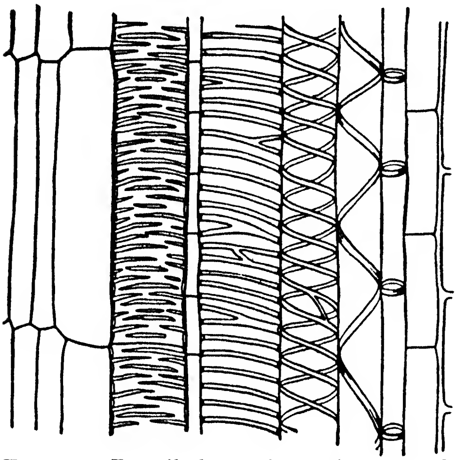

FIG. 5. Detailed section of area of mature cells in stem.

Maturing of Cells

Examination of the plant body back of the region of elongation reveals that the cells have greatly changed in form and structure (Fig. 5). The cells which have lost their cross walls have become a series of pipes, and are known as the water-conducting cells. A mature stem shows long fiberlike cells, which have thick walls and small cavities, and appear in the form of strands. The epidermal or skin cells are toothed and flanged and have a deposit of waxy material on the outside. Examination of the cortex or pith of most plants shows that the cells are filled with starch (Fig. 6).

All of these changes are manifestations of cell maturation or cell differentiation. Most important of these changes are (1) the thickening of the cell wall, (2) the formation of fibers, (3) the storage of starch, and (4) the accumulation of sugars. These changes are dependent on a supply of sugars, which must be available, in order that cells may mature or differentiate. However, if cell division is taking place, the sugars used for cell formation cannot be used for cell maturation.

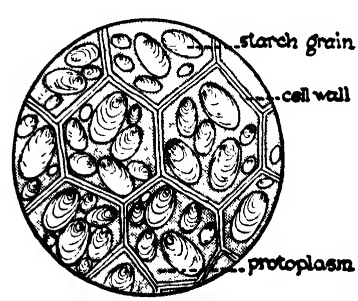

FIG. 6. Cells of a bean seed filled with starch grains.

VEGETATIVE-REPRODUCTIVE PHASES OF PLANT GROWTH. As previously stated, sugars are needed for the formation of protoplasm and for the making of new cell walls. When new cells are formed, the plant is actually developing its stems, leaves, and roots. Since sugars are needed for the making of new cells, they are also necessary for the development of stems, leaves, and roots. When the plant is developing its stems and leaves, sugars are being used, and this development is called the vegetative phase of plant growth.

Sugars are also used for the thickening of the cell wall, for the storage of starch, and for the formation and development of flowers and fruit. These changes are manifestations of the storage of carbohydrates, which takes place when the sugar is not all used in the development of stems and leaves, and in respiration. This development of fruits or seeds or storage organs is called the reproductive phase of plant growth.

The vegetative-reproductive phases of growth may be compared to a balance. One side of the balance may be considered the vegetative phase, the other side the reproductive phase. This concept presents three possible cases: (1) The vegetative phase may be dominant over the reproductive phase (the balance is tipped on the vegetative side), (2) the reproductive phase may be dominant over the vegetative phase (the balance is tipped on the reproductive side), and (3) the vegetative and reproductive phases may be proceeding in equal amounts (both pans of the balance are equal).

ENVIRONMENTAL INFLUENCE ON THE TYPE OF PLANT GROWTH. Environment is the sum total of our surroundings. Food, temperature and humidity of the air, and associations are part of our environment. They markedly influence our behavior.

The same is true with plants, since their growth and development are materially influenced by the various factors of their surroundings or environment. Since these factors affect the manufacture and utilization of sugars in a general way, they influence the growth and behavior of plants. The principal environmental factors which influence growth and behavior of vegetable crops are (1) the water supply, (2) light, (3) temperature, and (4) the nutrient supply.

Water Influence on the Vegetative-Reproductive Phases of Growth

To understand the factors of the environment which affect the water supply within the plant, the student must have a working knowledge of the factors which influence the income and the outgo of water. In

order to maintain the water supply within the plant, the intake should equal the outgo.

As stated before, water is necessary for cell division, for cell enlargement, and to maintain turgor.[1] In general, the amount of water going into a plant must equal that going out. When the intake is much less than the outgo, the cells lose their turgor and the plant wilts. Cell division is reduced when the intake of water is less than the outgo, even though wilting does not occur. When cell division is reduced, sugars accumulate, and when cell division stops or is retarded, the sugars which accumulate change into starch, cellulose, or lignin (the woody matter of plants), cell walls thicken, certain cells become woody, and others store carbohydrates in the form of starch. Therefore, when abundant water is available, other factors of the environment being favorable, plants are able to make and enlarge new cells. Hence, an abundant water supply favors the vegetative phase of growth. When moderate supplies are available, and other factors of the environment are favorable, the plant is unable to make many new cells and carbohydrates accumulate and the reproductive phase of growth is favored. This effect of water explains why an abundant supply is necessary to promote the rapid growth of lettuce, spinach, and other leafy vegetables, and how crops become woody when the weather is dry.

FACTORS INFLUENCING THE INTAKE OF WATER. Principal factors influencing the intake of water are (1) the area of absorbing surface, namely, the area and number of root hairs, (2) concentration of the soil solution, (3) amount of available water in the soil, (4) soil temperature, and (5) the soil's oxygen supply.

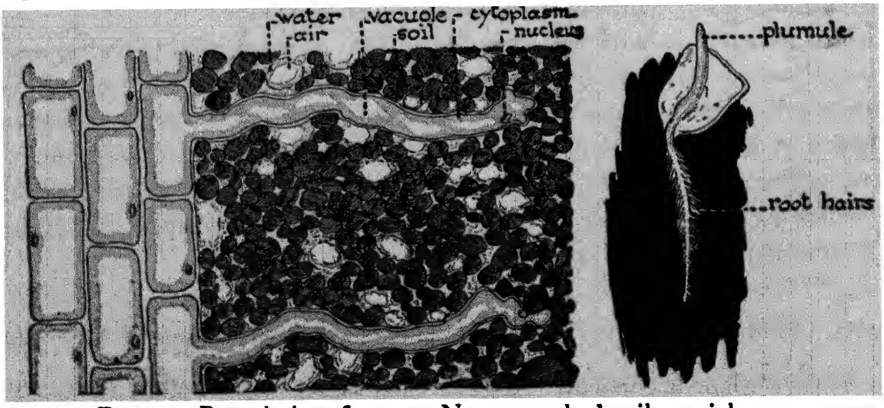

FIG. 7. Root hairs of corn. Note attached soil particles.

[1] Cells are in a state of turgor when they are fully stretched.

A primary function of the root is the absorption of water. However, not all the roots of vegetable crops absorb water. Water absorption is confined largely to the root hairs, which are found just back of the growing points in the region where the cells enlarge. They are simply tubular expansions of epidermal or skin cells (Fig. 7). By this expansion they greatly increase their water absorbing surface.

Inside the root hair, sugars and other materials are in a solution, which is normally more concentrated than the solution in the soil. Consequently, there is a diffusion of water, called osmosis, from the soil solution into the root hairs and into the plant. If the soil is cold, the movement of water in the soil will be slower than when it is warm. In addition, root hairs require moderately warm temperature for growth. The oxygen supply in the soil also influences water absorption. Root hairs need oxygen for respiration, and they do their best work when the soil is plentifully supplied with air.

FACTORS INFLUENCING THE OUTGO OF WATER. The principal factors influencing the outgo of water are (1) air temperature, (2) relative humidity, (3) light intensity, (4) air movement, (5) area of evaporating surface, and (6) the number and size of the stomata.

Air temperature, light intensity, air movement, the area of evaporating surface and stomatal diameter affect the outgo of water directly, while relative humidity affects the outgo of water indirectly. In other words, the higher the air temperature and light intensity, or the greater the evaporating surface (the stem and leaf surface), air movement, or the diameter of the stomata, the greater is the outgo. Conversely, the higher the relative humidity the lesser is the outgo.

An important gardening practice which affects the water supply within the plant is transplanting. Transplanting always destroys root hairs, hence it always decreases the water supply within the plant. Generally, vegetable crops transplanted in cloudy or drizzly weather recover more quickly from the check in growth incident to transplanting than those transplanted in sunny weather. Transplanting is discussed fully in Chapter 7.

Light Influence on the Vegetative-Reproductive Phases of Growth

The effect of light can be divided as follows: (1) Light intensity, (2) light duration, and (3) light quality. Light intensity varies with the season, being more intense in summer than in winter. In general, investigations have shown, within limits, that the manufacture of sugars is

proportional to the light intensity, provided other factors are not limiting. Consequently, the amount of sugars made in summer will be greater than in winter. Light quality refers to the length of the wave. Visible light consists of red, orange, yellow, green, blue, indigo, and violet rays. The red and violet rays of sunlight influence sugar manufacture more than the green rays.

Of more importance is the duration of light, which also varies with the season, as the light period is shorter in winter than in summer. Generally, more sugars are made in long days than in short ones. Experiments show that the length of day markedly influences the vegetative and reproductive phases of plant growth. Some plants flower during short days only, others during long days only, while others flower during short, medium, and long days.

Vegetable crops which flower or develop their storage organs during short days are certain varieties of Irish potatoes, Lima beans, and soybeans. Those which flower during the long days are spinach, spring radishes, and some varieties of onions.

Temperature Influence on Growth

Within rather narrow limits, generally between 40° and 85° F., the rate of cell division and growth is proportional to the temperature, provided other factors are not limiting. When the temperature is low, the rate of cell division and growth is low. When growth is slow, sugars are used less rapidly than when the rate of growth is high; hence in cool weather, other factors being favorable, sugars accumulate. At relatively high temperatures, growth is rapid and sugars do not accumulate, but are used in respiration and growth.

Vegetable crops differ in their temperature requirements. Some crops, such as melons, cucumbers, and eggplants, thrive best under a relatively high temperature, while others, such as lettuce and celery, grow best under a relatively cool temperature. However, the best temperature is not necessarily the temperature at which the plant makes the most rapid growth. The different vegetables are grouped according to seasonal preference in Chapter 2.

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4

VEGETABLE BREEDING AND IMPROVEMENT

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The vegetable industry is looking more and more to the plant breeder to solve its problems. Already, though the work has scarcely begun, spectacular results have been secured; namely, rust-resistant asparagus, mosaic-resistant spinach, yellows-resistant cabbage, wilt-resistant peas, watermelons, and tomatoes, mildew-resistant cantaloupes, and brown-blight resistant lettuce are among the contributions that have helped to save the industry in different districts. Each section has its own problems, which the breeder must solve by developing new varieties. Improvement is easy if plants with the desired characters can be secured by selection; but where hybridization must be used, the procedure may become somewhat complicated. Before planning a vegetable-breeding program, one must know something about the chromosomes and genes, so important in heredity, and about their behavior in growth and reproduction.

Cells, Chromosomes, and Genes

A plant or a portion thereof is shown by the microscope to consist of innumerable small cells. Many of these, especially the rapidly growing root and stem tips, contain a small round or elliptical body called the nucleus embedded in a mass of more transparent material, the cytoplasm. Within the nucleus are small rod-shaped bodies, the chromosomes, distinguishable only when the cells are undergoing division. All cells of the same species have the same number of chromosomes, occurring in pairs. In other words, every chromosome within a cell has its exact duplicate in size, shape, and composition. Each body cell of the onion (*Allium cepa*) contains 8 pairs of chromosomes, one set of 8 having been derived from the male and the other set of 8 from the female parent. At each cell division, during growth of the plant, these 16 chromosomes divide longitudinally, each daughter cell receiving chromosomes of the same number and composition as the mother cell. These chromosomes carry the factors or "genes" that determine whether a fertilized egg will develop into an animal or plant and whether the individual will

possess desirable or undesirable characters. Each character is the expression of one or more genes as modified by the environment. Characters are the attributes which identify an individual.

The genes are distributed along the chromosome like beads on a string, each in its definite location. During cell division, when the chromosomes divide lengthwise, all genes also divide, so that the two daughter cells have the same genic complex as the parent cell.

In most chromosomes there are probably several hundred genes, all tending to remain together as a unit. Genes belonging in the same chromosome are said to be linked; collectively they are known as a linkage group. A plant has as many linkage groups as it has pairs of chromosomes. When certain genes are linked, the characters they express will also be linked. In other words, linked characters tend to remain together more often than to be separated.

Not only are the chromosomes in pairs, but the genes on them are also in pairs, arranged in the same linear order. The two members of a pair of genes are called *allelomorphs*. If both members of a pair of genes are alike, the plant is homozygous (pure) at that point; that is, it will breed true for the character that depends upon this pair of genes for its expression.

Segregation and Recombination

In plant growth, when the body cells divide, the daughter cells receive the same number of chromosomes as were in the mother cell. In the flower, however, at certain times, another type of division known as reduction division occurs in cells preceding the formation of the sperms and eggs. Instead of each chromosome dividing, the pairs meet at the middle of the cell; then one member of each pair moves to opposite ends, and two cells are formed in which the number of chromosomes is

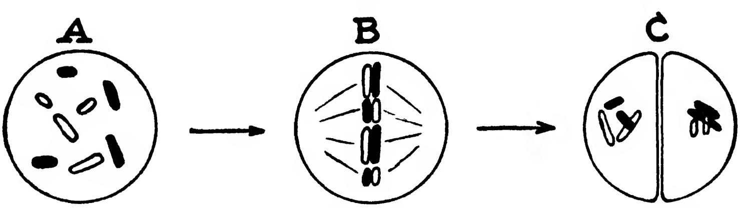


FIG. 8. The mother cell *A* contains four pairs of chromosomes. Those colored black have been derived from the male parent, the white from the female parent. Preparatory to reduction division (*B*) members of a pair meet at the center of the cell. *C:* Members of a pair have moved away from each other, and a wall has formed between. Note that the chromosomes derived from the male or female parent do not remain together.

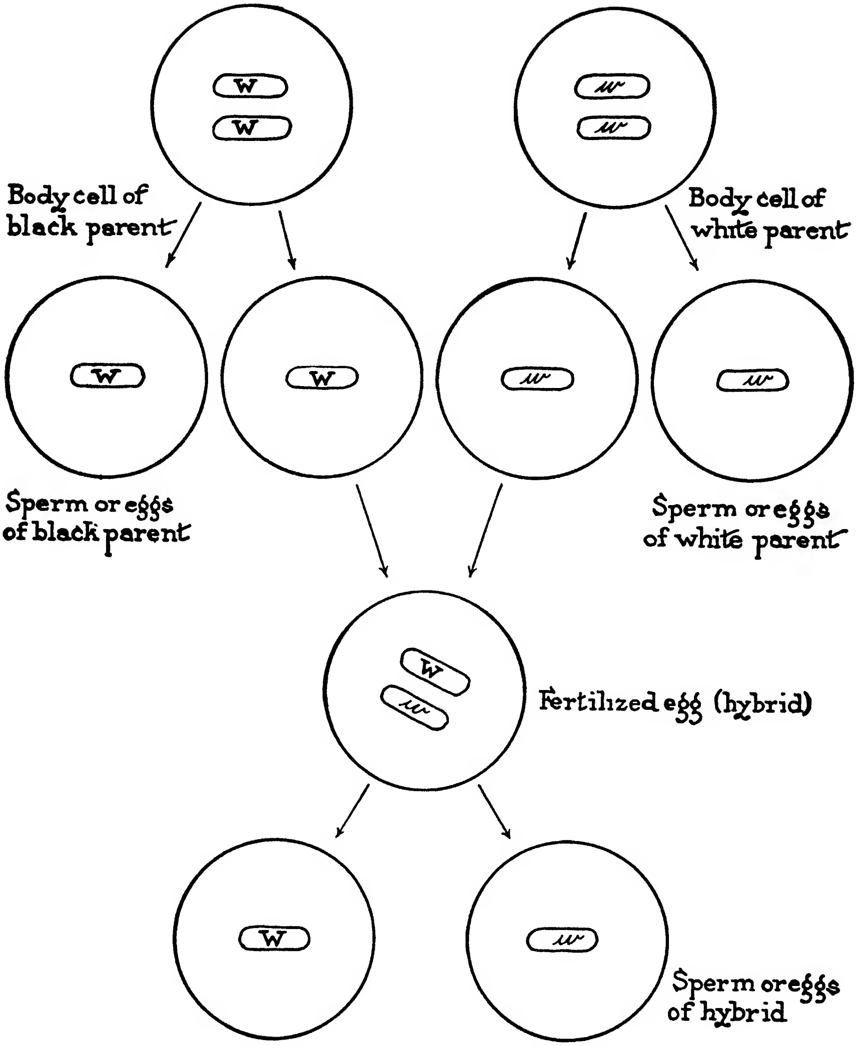


FIG. 9. This diagram shows only the pair of chromosomes carrying the genes *W* and *w*.

reduced to one-half that of the body cells (Fig. 8). The set of chromosomes derived from the one parent or the other do not remain together; they segregate in all possible combinations. For example, two varieties of corn differ only in kernel color: one is black, and the other white. This difference is probably determined by a single pair of genes. The genes for black can be represented by the symbols *WW;* the genes for white by *ww*. In the formation of the germ cells the black corn will produce sperms and eggs with the gene for black, and the white

corn, sperms and eggs with the gene for white (Fig. 9). When a cross is made, the chromosome number is doubled, and the pair of chromosomes containing *W* and *w* are present in the fertilized egg and in all the body cells of the hybrid. This hybrid will produce eggs and sperms one-half of which will have the chromosome with the gene for black (*W*) and the other half will have the chromosome with the gene for white (*w*).

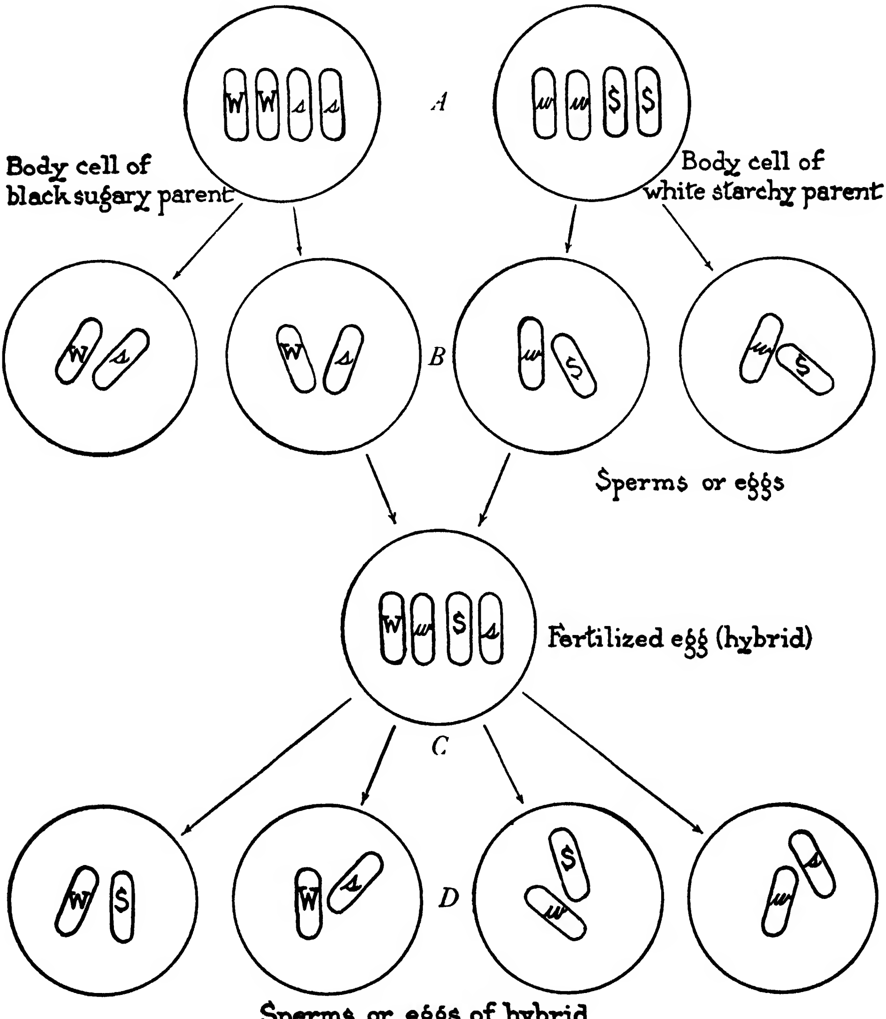


FIG. 10. *A:* Genic composition of two corn plants, one being pure for black sugary kernels, the other for white starchy kernels. *B:* Sperms or eggs, only one member of each pair present. *C:* Fertilized eggs (hybrid). *D:* Four kinds of sperms and eggs formed. Only those chromosomes and genes are represented with which we are concerned here.

When this hybrid (F_1) is self-fertilized, there will be three possible combinations between eggs and sperm — *WW*, *Ww*, and *ww*, as shown in the checkerboard (Fig. 11). Fertilized eggs will be produced in the ratio of 1 *WW* pure for black, 2 *Ww* hybrid for black, and 1 *ww* pure for white. The *Ww* plant will be black because in this case black is dominant to white. The white gene, though present, does not express itself and is therefore said to be recessive. The fertilized egg containing *ww* will produce a plant that will breed true for white; the *WW* plant will breed true for black; but the *Ww* plant, which is hybrid for kernel color, when self-fertilized will produce a progeny that will segregate again in the ratio of 1 *WW*, 2 *Ww*, and 1 *ww*. From external appearances the kernels can be classified into two color groups, black and white, known as phenotypes. From the standpoint of genic composition, however, they can be placed in three groups, or genotypes.

Sperms \ Eggs	W	w
W	WW black	Ww black
w	wW black	ww white

FIG. 11. Checkerboard to demonstrate all possible combinations between eggs and sperms when the F_1 hybrid for the genes *Ww* is self-fertilized.

A hybrid differing in a single pair of genes as above is a monohybrid; one differing in two pairs of genes is a dihybrid. If the black corn is also a pure sugary type, the genes can be represented by the letters *WWss*; and if the white corn is pure for starchiness the symbols *wwSS* can be used, the capitals denoting dominant genes. The sperms and eggs of the black sugary plant will all contain genes *Ws*; those of the white starch plant genes *wS* (Fig. 10). The fertilized egg and all body cells of the hybrid (F_1) will contain *WwSs*; the kernels will be black and

Sperms \ Eggs	WS	Ws	wS	ws
WS	WS WS black starchy	WS Ws black starchy	WS wS black starchy	WS ws black starchy
Ws	Ws WS black starchy	Ws Ws black sugary	Ws wS black starchy	Ws ws black sugary
wS	wS WS black starchy	wS Ws black starchy	wS wS white starchy	wS ws white starchy
ws	ws WS black starchy	ws Ws black sugary	ws wS white starchy	ws ws white sugary

FIG. 12. Checkerboard to demonstrate all possible combinations between eggs and sperms when the F_1 hybrid for the genes *WwSs* is self-fertilized.

starchy. At reduction division 4 kinds of eggs and sperms will be formed: *WS*, *Ws*, *wS*, and *ws*. When this hybrid plant is self-fertilized, eggs and sperms will unite in all possible combinations, best illustrated with a checkerboard (Fig. 12).

In the resulting progeny (F_2) there are four phenotypic classes; namely, 9 of the plants will have black starchy kernels, 3 black and sugary, 3 white and starchy, and 1 white and sugary. The plant in the upper left-hand corner is pure for black and starchy, the one in the lower right-hand corner is pure for white and sugary. These two plants, therefore, represent a new combination of characters. Although phenotypic dihybrid ratios other than the 9 : 3 : 3 : 1 occur frequently, lack of space prevents their consideration.

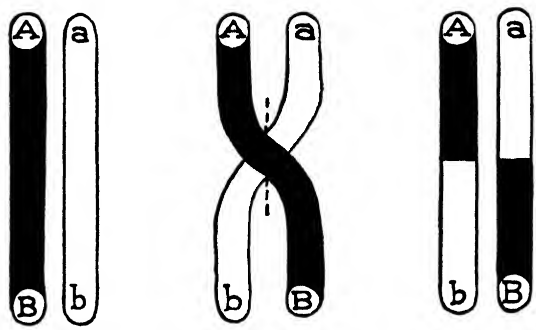


FIG. 13. In this figure, on the left, are shown two genes, *A* and *B*, and their allelomorphs in opposite ends of a pair of chromosomes. A break causing an exchange in similar parts of a pair of chromosomes would place *A* and *b* in one member and *aB* in the other member of the pair. This phenomenon is known as crossing-over.

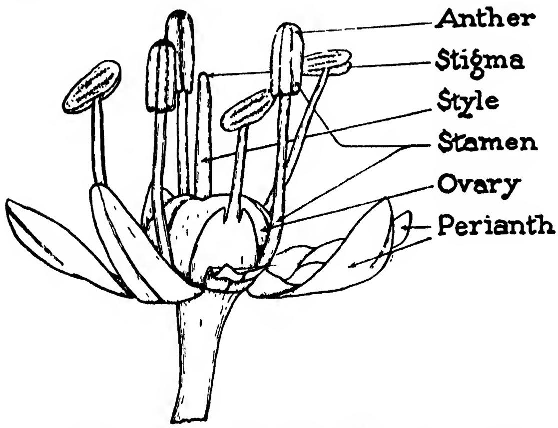
If, in a certain case, the genes *A* and *B* occurred in the same chromosome and their allelomorphs *a* and *b* in the other member of the pair (Fig. 13), then, more of the eggs and sperms would contain the *AB* and *ab* combination than *Ab* and *aB*, and segregation in the F_2 would not correspond to the 9 : 3 : 3 : 1 ratio. Fortunately for the breeder, even two genes in the same chromosome do not always remain together. At some stage in the early reduction division, when the members of a pair of chromosomes lie close together, a break occasionally occurs, and there is an exchange of homologous parts, known as crossing-over. More breaks occur between two genes located far apart on a chromosome than between two that are close together. Where genes are closely linked, one must usually grow a large number of plants in order to secure the desired cross-over.

Flowers, Pollination, and Fertilization

People do not, as a rule, think of plants in terms of sex, mainly because the two sexes are not always separated as they usually are in animals. In only a few vegetables (spinach, asparagus) are the sexes in different

plants. Sex is expressed primarily in the flower parts; and when making crosses one must distinguish male from female whether they be in the same flower (perfect), in different flowers of the same plant (monoecious), or in different plants (dioecious).

Most species of vegetables have four whorls of floral organs, sepals, petals, stamens, and pistil (Fig. 14); some lack one or more whorls. From the standpoint of reproduction only the stamens and pistils are important. The stamen, or male part of the flower, contains within its mature anther a yellowish powder called pollen that produces the sperms. The pistil, or female part, has within its ovary one or more small, white, kidney-shaped objects, the ovules, which contain the eggs.



Truck-Crop Plants. McGraw-Hill Book Co., Inc., New York.

FIG. 14. Onion flower. Inner whorl of stamens has dehisced.

The transfer of pollen from the anther to the stigma of the pistil is called pollination. Self-pollination occurs when pollen is transferred from the anther to the stigma of the same flower or from one flower to another of the same plant; cross-pollination when the transfer is from one plant to another. Plants that depend upon insects and wind are mainly cross-pollinated. Asparagus, onions, and cabbage are pollinated chiefly by insects; spinach, beets, and corn by the wind. In peas, beans, lettuce, and tomatoes self-pollination is the rule.

Once deposited upon the stigma, the pollen germinates; a small tube containing the two sperms penetrates the stigma and grows down the style to the ovule, absorbing food for growth from the tissues through which it passes. The time required for the pollen tube to reach the ovule may be a few hours or several days, depending upon the crop. One sperm unites with the egg in fertilization; from this union a new individual develops. The second sperm unites with two other nuclei (polar nuclei) located near the egg; from this union develops a tissue called the endosperm, which nourishes the developing embryo.

The technic of breeding the several vegetable crops is specifically discussed later in this chapter.

Variation

It is rare that two plants are exactly alike, no matter how uniform the variety to which they belong appears en masse. The variations between plants may be of two types: those caused by the environment and those caused by the difference in genic make-up of the chromosomes. Variations caused by a difference in environmental factors such as moisture, temperature, and light are not inherited. Their principal effect is upon the size of the plant or its parts.

Variations originating in the genic material of the chromosomes are heritable. They may arise in several ways — as a recombination of characters; change of a single gene; change of several genes; loss or gain of a portion of a chromosome, an entire chromosome, or whole sets of chromosomes. Crop improvement is possible because plants do differ in their heritable characteristics.

Methods of Improvement

The methods now in vogue for crop improvement are chiefly selection and hybridization or a combination of the two. The method used depends upon the crop and the end sought. For our purposes here, crops are divided into three groups: (1) those naturally self-pollinated, (2) those naturally cross-pollinated, and (3) those vegetatively propagated. Lack of space limits the discussion to a few of the crops in each group.

PLANTS NATURALLY SELF-POLLINATED. Important vegetable crops naturally self-pollinated include lettuce, peas, beans, and tomatoes. In them self-pollination is not absolute; some crossing occurs in all. They do not lose vigor with inbreeding.

Peas. As pea varieties occur on the market, their most serious defect is mixture with other varieties. A variety that possesses more than one type should be pure lined and the desired type restored by selecting ten or more single plants having what is considered ideal type. Seed of the selected plants is saved from each plant separately and the following year is seeded in widely spaced rows; or, better still, the rows are separated with chick peas or some other crop. If several varieties are to be pure lined, they had best be separated by several rows of corn, sunflowers, or other crops. Type should be observed throughout the growing season. In pea varieties with broad stipules, for instance, where rabbit-ear rogues are a real problem, lines should be destroyed in the early generations before they come into bloom if there is an indication of more than

1 : 1000 of this rogue. Of the remaining lines only the best three are saved. The following year the best of these is increased in a naturally isolated spot, or other crops are used to provide isolation. The other two are held in reserve in case the one selected should later fail to come up to expectations. In harvesting, the selected lines should be pulled and tied in small bundles or kept in well-ventilated bags until ready for threshing, which should be done by hand, by flail, or by some other method that prevents mixing.

The work of hybridization and breeding, however, will lead to the greatest progress in disease resistance, adaptability, quality, and yield. For crossing, large, well-developed, unopened buds should be selected for the female parent. After a little experience one can tell when a bud has shed its pollen, because a yellow pollen stain shows through the keel petals. The keel of the selected bud should be split open with the points of tweezers. A slight pressure toward the base causes the split keel to open so that the ten stamens can be counted and removed. From the male parent only fresh pollen should be taken. Though actual transfer may be done with the tweezers, some prefer to strip a flower of petals and stamens and to use the remnant for smearing pollen on the stigmatic surface of the flower from which the stamens have been removed. The keel is then closed, and the flower protected against insects for a few days by a small glassine bag. In dry weather, a little wet cotton may be inserted in the neck of the bag. In the field the bag must be supported with bamboo stakes or laths to prevent damage by wind. Often the competing flowers or pods on the same vine should be removed.

Usually the only observation necessary in the F_1's [1] is to make sure a cross has taken place. F_1 hybrids should not be discarded, for it is usually in the second and subsequent generations that desirable character combinations are secured. One must fix the type before increasing for distribution.

Beans. Though the general breeding program in beans resembles that for peas, natural crossing is more prevalent. It may be desirable, therefore, to select plants early and cover them with muslin cages. Growing the first few generations in screened greenhouses from which bees are excluded is a good precaution against natural crossing.

Although bean and pea flowers are very similar, bean crosses are more difficult to make; the style is curled like a ram's horn and is usually so brittle that many are broken in an effort to open the keel. Also the

[1] The term F_1 refers to the plants of the first generation following the cross.

FIG. 15. Method of selfing onions. Corn is planted as a windbreak.

flower stem is very delicate. Emasculation is done at about the same stage of maturity as in the pea. Pollen is not very plentiful and is not viable as long as that of the pea. Crosses are best made in a greenhouse, with the humidity near saturation. Field crosses should be covered with glassine bags with bits of water-soaked cotton included. High humidity should be maintained from 2 to 7 days.

Lettuce. Lettuce-seed breeders usually go through the fields about the time the plants are in prime condition for market and select and mark with small stakes the plants possessing the desired qualities. In the heading types, the heads are quartered so that the seed stem can emerge. Before the first flower opens, the entire plant is covered with a cloth sugar sack to prevent cross-pollination. The open end of the sack is tied about the base of the plant, the closed end to a stake driven beside the plant. The plants are kept covered until dried and ready for threshing. Next year the different lines are compared, and the undesirables eliminated.

For crossing one must remove the pollen from the florets by use of a fine stream of water after the corolla has expanded and the style is fully extended. The stigmas are dried, and pollen is added by removing a fully expanded flower head of the male parent and rubbing the pollen on the depollinated one. Before the florets open, the heads of both parents should be covered with one-pound manila paper bags.

PLANTS NATURALLY CROSS-POLLINATED. Most vegetable crops are naturally cross-pollinated. Asparagus, which is dioecious, is entirely cross-pollinated; corn, which is monoecious, is more than 99 per cent cross-pollinated. Other important crops in this group are melons, squashes, pumpkins, beets, spinach, onions, and carrots. Certain of these, especially corn, carrots, and onions, lose vigor with inbreeding, whereas melons, squashes, and pumpkins usually do not.

Onions. Many commercial varieties of onions need to be made more uniform for such characters as size and shape, flesh and scale color, and time of maturity. Varieties should be resistant to insects and diseases, produce better yields of seed, and keep well.

For purifying and making a variety more uniform, select a large number of bulbs that approach the ideal for the variety, and self by covering the entire umbel with a one-half pound manila bag when the first flower opens (Fig. 15). Tie securely to keep out insects, and tap vigorously each afternoon to facilitate pollination. Grow progenies of each of the inbred plants separately. Destroy undesirable lines during the growing season, or at harvest time, or upon their removal from storage. Plant 25 or 30 of the best lines for seed, using only the best bulbs. Bag two or three umbels on each plant, but allow one or more

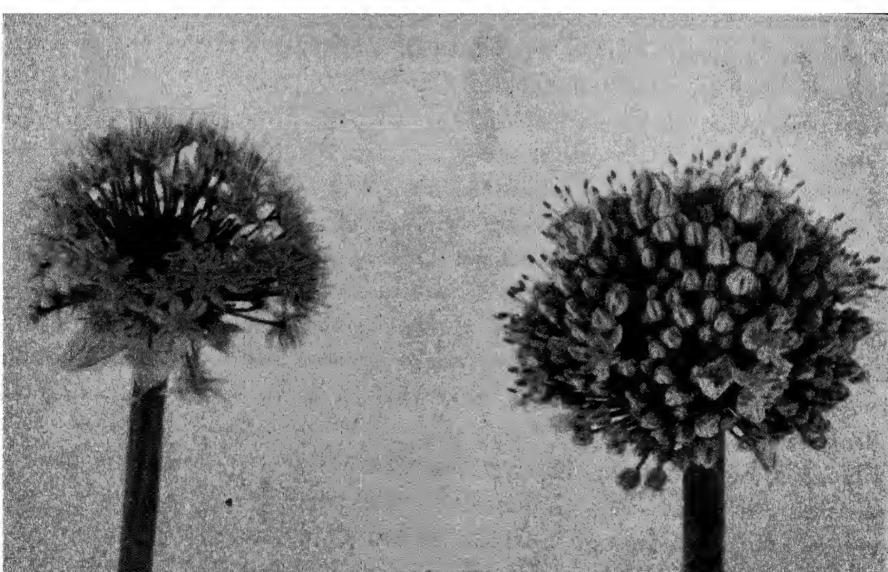


FIG. 16. The onion head on the left has been emasculated and disbudded preparatory to crossing.

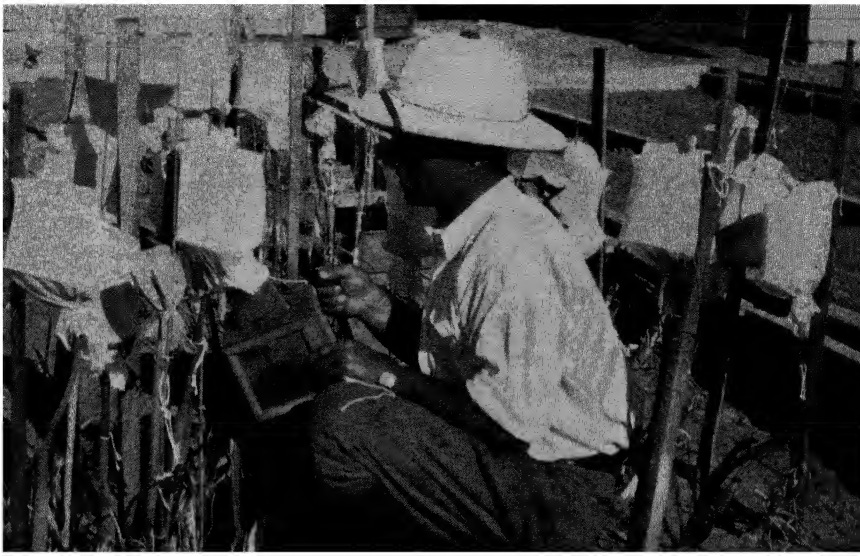


FIG. 17. Showing type of cage used for onion crossing and method of adding flies.

on each plant to open-pollinate in order to secure a quantity of crossed seed, which should be better than that of the commercial parent. Plant the bagged seed again as single plant progenies, and select the best. By bagging a portion of the heads on a plant and allowing others to open-pollinate, one can purify the variety while increasing seed for commercial production. In the inbreeding program, carry along 25 or 30 lines derived from different bulbs at the first selection; crossing between unrelated lines will restore the vigor lost by inbreeding. When the desired uniformity has been secured, inbreeding is no longer necessary.

For crossing, remove the stamens just after the flower opens and before the pollen is shed. Bag the umbels of both parents as soon as the first flower opens. The number of flowers on an umbel opening daily increases until full bloom. On the female parent, remove the flowers several times daily before pollen is shed. At full bloom 50 or more flowers may open. Emasculate these, and remove the remaining buds on the umbel (Fig. 16). After about 24 hours the stigmas will be receptive, and crossing can begin.

The most effective method of crossing is the use of flies. An umbel that has been emasculated is enclosed within a small cheesecloth cage, and one from the pollen parent is enclosed with it, the base of the stalk resting in a jar of water to insure pollen shedding for several days. Flies are then added to the cage (Fig. 17).

To insure a supply of flies and to exclude foreign pollen, these insects are grown under controlled conditions. The equipment need not be elaborate. In a galvanized pan about 6 inches deep, of convenient length and width, is placed about 1 inch of finely screened sand. Within this pan is a low movable table, also covered with a thin layer of sand. On this table are placed the beef lungs upon which the flies lay their eggs. When the maggots stop feeding and begin to wander, they fall from the table into the pan below, burrow into the sand, and form pupae. These are usually separated daily from the sand by screening and then placed in small screen cages about 6 inches square with a cone-shaped top, at the apex of which is a small opening stoppered with a cork. Within a few days, depending upon the temperature, the flies begin to emerge and move into the cone. To introduce flies for pollination, insert the cone into the lower end of the cloth cage, remove the cork, and allow as many flies as needed to escape. They soon begin to feed, thus accomplishing pollination.

Carrots. The method of purifying carrot varieties is much the same as for onions. For the most rapid progress, some selfing is usually necessary; but to regain vigor one must follow selfing with

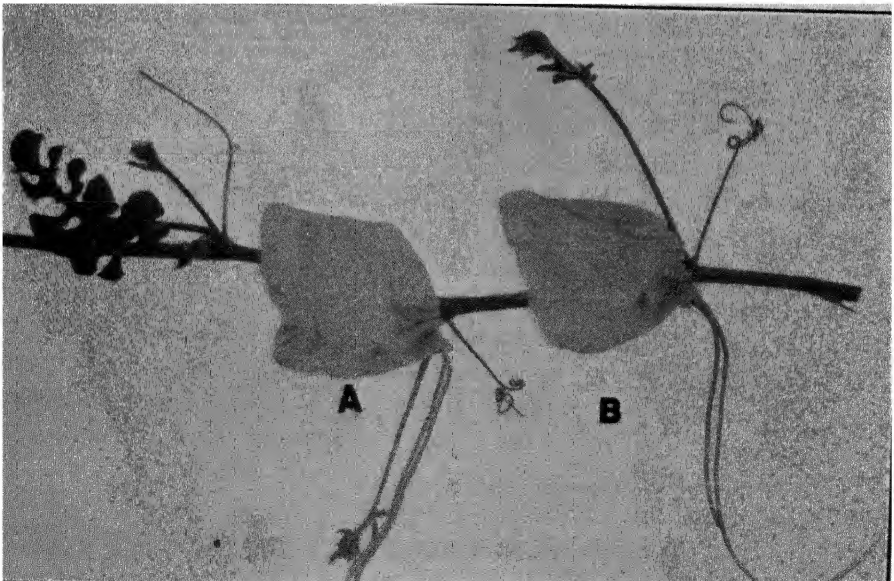


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FIG. 18. Watermelon pollination, showing cloth bags in place over pistillate flower A and staminate flower B. These bags are placed over the flower buds during the afternoon or evening preceding anthesis.

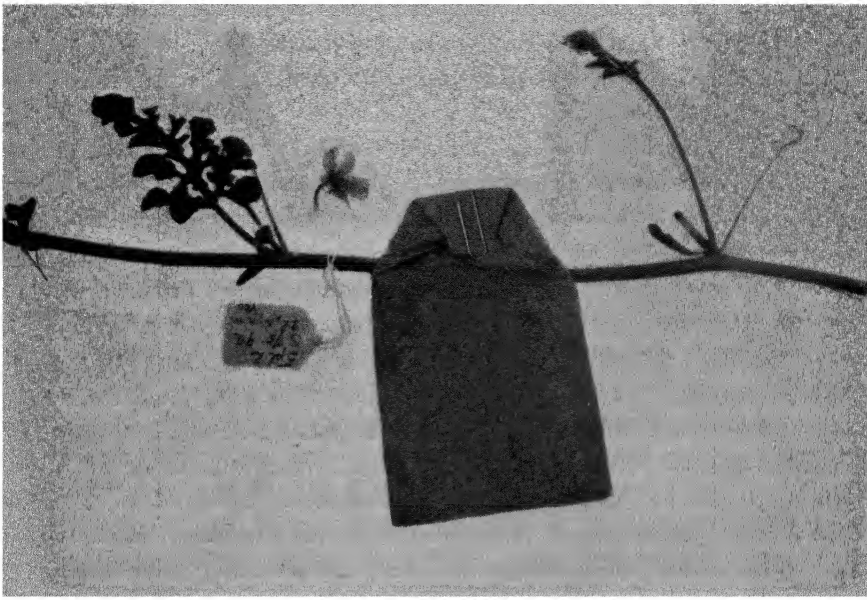

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FIG. 19. Watermelon pollination. Paper bag securely fastened over pollinated pistillate flower with pollination data on tag.

crossing, which is best accomplished by intermingling several unrelated lines.

For selfing, the selected mother roots are spaced about 4 by 4 feet. A galvanized cylinder about 10 to 18 inches in diameter and about 12 inches high is partly sunk in the ground around the carrot plant. Inside the cylinder is set a 6-foot stake to which are fastened one or more wire hoops about 2 feet in diameter. A muslin bag, open at both ends, is pulled down over the stake and hoops and tightly secured to the cylinder at the bottom. Flies are added from time to time throughout the flowering period. Good yields of selfed seed are usually secured by this method.

Crossing is also a very simple procedure in the carrot. To prevent contamination, single umbels of both parents are covered with small muslin bags before flowers open. Not all the flowers in an umbel open at the same time; but the youngest lose their stamens before the oldest become receptive, making emasculation unnecessary. When the stigmas of the oldest flowers of the female parent start to spread apart, an umbel-bearing branch of the male parent is introduced into the cage, and the cut end placed in a bottle of water. Flies are used as the pollinating agency.

Watermelons. Although naturally cross-pollinated, the watermelon seldom loses vigor with continued inbreeding and therefore can be purified and improved by selecting and selfing desirable individuals. Most watermelon varieties are monoecious, with about seven male flowers to every female on a plant. Open female flowers usually appear 12 to 18 inches from the end of the runner; males at an older node on the same runner. Flowers of both sexes usually open in early morning, the exact time depending upon the air temperature during the preceding night. Pollen is often shed one to three hours before anthesis and may continue until late afternoon. The stigmatic surface of the female flower appears receptive at anthesis. To accomplish selfing, both male and female flowers are selected and covered with small muslin bags before the flower opens (Fig. 18). As soon as possible after anthesis, the cloth bags are removed, the staminate flower is pinched off, and its pollen is applied to the stigmatic surface of the pistillate flower. A one-pound manila paper bag is then slit for about 3 inches down each side, folded tightly over the pollinated flower, and fastened with a clip (Fig. 19). After two days the paper bag is removed. In making crosses the technic is the same as in selfing except that different plants are involved.

In selfing plants that also bear hermaphroditic flowers, one need not bag the males; the hermaphroditic flowers contain sufficient pollen. For crossing, it is best to emasculate the evening before the flower opens.

VEGETATIVELY PROPAGATED PLANTS. Vegetable crops propagated chiefly by vegetative means are potatoes, sweet potatoes, globe artichokes, rhubarb, and garlic.

Potato. Though potato breeding at present is being directed toward the development of disease-resistant varieties, many other characteristics must be considered. Most of the actual breeding is done in localized districts of the North where conditions favor the production of flowers and the setting of seed. There are districts in the South and in the higher altitudes where favorable conditions also prevail.

A given potato variety when propagated by cuttings is very uniform, but when propagated by seed it develops new characters not apparent in the vegetatively propagated stock. No two seedlings appear exactly alike, and each is potentially a new potato variety. Some of these seedlings may be resistant to one or more diseases, may be more fertile than the parents, or may have other desirable characteristics. These may be increased as new varieties; or they may be selfed until they are pure for these characteristics, then crossed with plants having other

desirable attributes, so that the characters of both parents are combined in the F_1. In crossing, all buds sufficiently mature on a single cluster are emasculated about 24 hours before they open; others are removed. The entire cluster and several leaves are then enclosed within a one-pound manila paper bag and securely tied. In one or two days the flowers are pollinated. The following year the seedlings are grown, and promising ones increased for further testing. This method resembles the one used with such success in corn breeding, but in the potato it is even more valuable because the desirable combination, once secured, can be maintained indefinitely by vegetative propagation.

Sweet Potato. The commercial sweet potato crop is grown from either slips or vine cuttings. Improvement must be made either through the selection of favorable mutations or by breeding methods. In the Porto Rico variety of sweet potato, the mutation rate is fairly high, Miller of Louisiana having observed a mutation in about every 7,000 plants. The sweet potato does not bloom in most districts of the South, but favorable conditions do prevail in certain of the West Indies. The sweet potato flowers closely resemble those of the morning glory, to which it is closely related. Cross-pollination is the rule, and the plants are highly self-sterile. For crossing, buds that will open the next morning are emasculated in late afternoon. Flowers that are to be used as the pollen parent are also bagged in the bud stage to prevent contamination. Pollination is performed the next morning by rubbing the pollen-bearing anthers directly against the stigma. Then the flower is covered. The seed pod matures in 6 to 8 weeks. While actual crossing is done in a rather restricted area, the seedlings are tested in the various states. Selections are made for yield, edible quality, disease resistance, starch content, and other characters. A desirable seedling, once secured, can be maintained indefinitely by vegetative propagation.

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5

SEEDS AND SEED GROWING

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A seed is an undeveloped and dormant plant, usually with reserve food supply and protected by seed coats. It results from union of the male nucleus from the pollen grain with the female or egg nucleus in the ovary of the flower. It carries a combination of the hereditary characters of the two parents. When air, warmth, and moisture are favorable, the little plant starts to grow.

The product as harvested by the planter may be much worse than the seed from which it has sprung, but it can be no better. The hereditary content of the little seed sets the upper limit of both performance and quality. We can do much with fertilizer, water, and care to get out of a plant the best that it has, but we can get no more than it has received from its parents.

The price of seed for most vegetable crops is a small fraction of the total cost, and merit in seed may greatly increase yield or selling value or both. Hence, the utmost care is called for in buying seed, and one may well afford to pay increased prices for seed, provided he is satisfied value is delivered.

The Characters of Good Seed

Good seed is (1) clean, (2) disease-free, (3) viable, and (4) of good heritage.

To be clean, seed must be free of foreign matter, such as other kinds of seeds, dirt, or plant fragments. Vegetable seeds seldom seriously cause trouble in this respect.

FREEDOM FROM DISEASES. Seed should not carry disease to infest the crop. The best way is to have seed that grew without contamination. This is one of the great factors determining where seeds of various kinds are produced. In some cases poison treatments destroy diseases on the outside of the seed, such as red copper oxide for damping-off fungi. In other cases, heat (hot-water treatment) will kill fungi within the seed, as with black-leg of cabbage. Great care must, however, be used not to hurt the little plant.

VITALITY OF SEED. Seed must have sufficient vitality to complete the process of germination. The little plant must be able to break the soil, bring its leaves above ground, and bring its roots into effective contact with the soil, so that it may grow independently of materials stored within its coats. Growth prior to that stage may be described merely as sprouting.

Most good seedsmen test their seeds and sell only seed of high viability. Many seedsmen now mark percentage of germination on packages, and some states require this practice by law.

SEED TESTING. A correct stand of plants in the field is very important. It costs nearly as much to cultivate half a stand as a full stand, and over-seeding results either in costly thinning or harmful crowding. So the planter should know what his seed will do under his own conditions of soil, temperature, and moisture. Much seed a year or more old is usable, but one must know its viability to use it safely.

Probably the best test for casual use is to plant counted seeds in rows in a flat of the soil to be used or in a greenhouse bed, covering as usual. The temperature and moisture are kept constantly favorable, and the

Associated Seed Growers, Inc.

FIG. 20. The "rag-doll" sprouting test gives a satisfactory indication of the vitality of coarse vegetable seeds.

seedlings counted after they appear, calculating the percentage of germination.

Another way is to count out the seeds, placing them between folds of blotters or cotton flannel in a dish with water enough to keep them moist but not enough to exclude air. The dish is kept at a temperature of about 70° F. and sprouts are counted. Weak or slow sprouts should not be counted, as they may not be able to get through the soil under field conditions. The "rag-doll" test is good for coarse seeds such as peas, beans, and sweet corn. Seeds are counted out on long strips of cotton flannel or other cloth and properly marked. The cloth is then rolled up, moistened, and kept at about 65° or 70° F. The sprouted seeds are later counted and the percentage calculated (Fig. 20).

Seed testing has become a highly technical enterprise and good laboratories do not always agree perfectly. Nevertheless, both professional and home testing are of great value. Tests must be made carefully and, in case of doubt, they should be rechecked, checked with seedsmen, or with the state seed laboratories.

Different kinds of seed require different conditions of temperature, aeration, and even light. For example, spinach will not germinate well in very warm weather, even though there is moisture in the soil. Also, some seeds, such as lettuce, undergo a period of dormancy just after harvest when viability is very low. Light is effective in breaking this dormancy.

LONGEVITY OF SEED. A sample of celery seed 15 years old gave a 50 per cent stand in a trial a few years ago, and other kinds occasionally perform similarly. Onions, sweet corn, and parsnips are known to be unreliable the second season and should be used only after satisfactory test. When it is desirable to use old seed, a careful test should be made and the rate of sowing increased accordingly. Table 5 gives a general idea of the length of time seeds may be expected to retain their vitality under normal conditions. Information on the different kinds of seed appears in the special crop chapters.

SOUTHERN SEED STORAGE. Changes in temperature alone seem to have little influence on the vitality of seed. If seed is dry, freezing is harmless, as is heating to any ordinary atmospheric temperature. Let the climate be humid or the seed moist and the seed is soon worthless. Onion seed stored 8 months in Michigan lost nothing in vitality, while a similar lot in Alabama declined to zero. Tomatoes, watermelons, and radishes suffered less. Keeping seed in the South

is thus something of a problem, apparently due largely to high humidity. Seed should be dry and packages should be tightly sealed, though perhaps not filled too full. Doubtless tight chambers could be kept sufficiently dry with calcium chloride. Cold storage under reasonably dry atmosphere is also employed. Details of Southern seed storage are not well worked out and careful research is needed, some studies being already in progress.

TABLE 5. LENGTH OF TIME SEEDS MAY BE EXPECTED TO RETAIN THEIR VITALITY[1]

Kind of Vegetable	Years	Kind of Vegetable	Years
Asparagus	3	Onion	1
Bean	3	Parsley	2
Beet	4	Parsnip	1
Brussels sprouts	4	Peas	3
Cabbage	4	Pepper	2
Cantaloupe (Muskmelon)	5	Pumpkin	4
Cauliflower	4	Radish	4
Celery	5	Rutabaga	4
Cucumber	5	Spinach	4
Eggplant	5	Squash	4
Endive	5	Sweet corn	1
Kale	4	Tomato	3
Lettuce	5	Turnip	4
Okra	2	Watermelon	5

[1] When stored under favorable conditions, seed of the age indicated (from harvest, not from time of purchase) should be viable. Seed is often good much longer and specific lots may not survive so long.

SIZE OF SEED. If one sifts the seed and plants the larger ones, will he harvest a better crop? Much study has been focused on this problem with considerable confusion of results, but it seems to resolve itself into the following: Larger seeds give a slightly earlier and materially more uniform maturity. Medium-sized seeds will also mature evenly. Sizing the seed makes it possible to sow more perfectly with seeders or drills, which gives more perfect stands. These advantages make it profitable in some cases to separate into three sizes, planting the two larger sizes separately, but discarding the small seeds, many of which are weak or improperly matured.

TRUENESS TO A GOOD NAME. After all, the important point about seed is what kind of plant and product it will bring forth, and

how it will perform. So far as the seed is concerned, this is mainly a matter of heredity. The seed must truly represent a good variety and a strain suitable for the conditions and markets contemplated. These matters are not so easily measured as count per ounce or percentage of viability, but they are just as important.

CLASSIFICATION OF VEGETABLES. To buy seed satisfactorily, one needs to understand the classification of the various forms of vegetable plants. The different vegetables are classified botanically in Chapter 2.

A horticultural classification of the vegetables includes the following gradations: (1) The kind, (2) the variety, (3) the strain, and (4) the stock, each of which will be discussed separately.

Kind. A kind includes all the plants which, in general usage, are accepted as a single vegetable, as, for example, tomato, cabbage, bean. This is not the same as the genus or the species of botanical classification. The species *Brassica oleracea* includes several kinds (cabbage, cauliflower, and others). The beans come from more than one species (*Phaseolus vulgaris*, *P. lunatus*, and so forth).

Variety. A variety includes those plants of a given kind which are practically alike in their important characteristics of plant and product. Each variety should be distinct from all others in one or more prominent and significant features. Named varieties that are not distinct should be classified as strains of a recognized variety or as mere synonyms.

The line between varieties is not sharply drawn and is at present a matter of informal consensus, which results in great confusion. The only prospect for making varieties definite lies in the establishment of some generally accepted authority, such as the United States Department of Agriculture or a national board of vegetable nomenclature. Well-conducted studies of variety characters have much weight in establishing types and must be made before the present situation can be cleared up.

Strain. A strain includes those plants of a given variety which possess its general characteristics but which differ from others of the variety in one important, or two or three minor, respects, differences not great enough to justify a new variety name. Thus Red Kidney is a standard variety of bean and Wells Red Kidney is an anthracnose-resistant strain of this variety. Golden Self-Blanching is a standard celery, while Tall Golden Self-Blanching is the same variety, but is more

vigorous, earlier, and more spreading, and has broader and thinner leafstalks. The distinction between variety and strain is based simply on degrees of difference.

Stock. A stock represents all plants of the same parentage or pedigree. Differences between various stocks of a variety or strain should be very slight. A seed grower may maintain more than one stock of a strain, each representing a single pedigree line. Two seed growers may have stocks so nearly alike as to be indistinguishable, but as long as they are separately maintained, they are distinct stocks.

The distinctions of the definitions of strain and stock are not hard and fast; in fact, the seed trade is anything but consistent in its use of terms. The idea of a stock as distinct from a strain is based on the concept of parentage or pedigree lines. While some seed houses practically ignore the pedigree idea, many keep careful records and are able to trace parentage through several generations. At the same time, stocks of presumably nearly equal excellence are often used interchangeably.

As the buying public becomes more discriminating and willing to pay for greater care in seed production, the pedigree idea is finding fuller application in trade practice.

VEGETABLE TRIALS. The term "trial" usually refers to growing, observing, and recording the characteristics of plant and product of a given sample of seed, while the term "testing" is usually used in connection with purity and germination. Trials are the means of knowing the character of the stocks which are planted. They may be very simple, mere observation of a planted sample in comparison with another, or only in comparison with a memory-picture or an idea of what is wanted. Trials may be elaborate and exhaustive, involving great care in procuring samples, in repeating the plantings, in seeing that growing conditions are uniform, in making many and careful observations, many of them by weight or measurement and dealing with many characters. Such elaborate trials are carried on by the United States Department of Agriculture, the state experiment stations, and by many progressive breeders and seedsmen. Results appear in public bulletins and in catalogues and variety manuals of seedsmen.

The grower himself may well depend on other observers for the main points about a new offering, but he must himself make the final fitting to his own situation. This means simple but careful trials and comparisons on a small scale before large plantings are made. Novelties

are often alluring and every advance comes first as a novelty. Thus one is not wise either to ignore the new things or to make sudden shifts from the old to the new.

Anyone interested in careful trial of samples of vegetable seeds may make his own list of points to be observed. He may find schedules of points in many variety bulletins, and he may write for suggestions to experienced workers who are usually glad to help. The tabular system of recording observations enters characters across the top of the sheet and names or numbers of samples at the side or vice versa. Thus, a character at a time may be studied for all samples and notations may be made in harmony with one another, thereby avoiding the "drift" of one's impressions that is bound to occur if all characters of small early sorts are described at first and those of the large late sorts are taken up later. Measurements are accurate, easily read, easily compared, and easily handled statistically. Brevity and ease of reading are served by using ratings instead of words, 1 representing a very low degree of a character, 5 medium, and 9 high. Intermediate steps may be used as needed. Mechanical methods should not, however, crowd out the general estimate of merit and informal comparisons that may be less scientific but none the less enlightening.

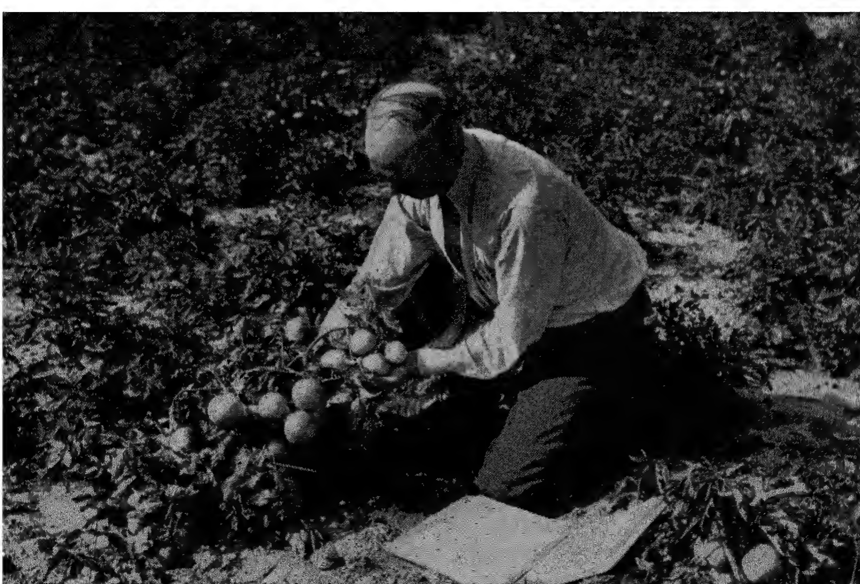

FIG. 21. The grower may learn much by observing and recording the characteristics of promising plants.

The grower may learn much from his own short trial rows, but the final verdict will depend upon field performance. Matters of evenness of maturity, small differences in earliness (often important in marketing), yield, ease of harvesting and handling, holding up in marketing, and table quality may be revealed only in very elaborate, formal trials, with many replications and carefully measured observations. After all, a crop or perhaps several crops must be grown to tell the whole story.

Thus in any trial, much depends upon knowing what is sought, upon developing keen power of observation, and upon making notes clearly and accurately, even though not elaborately (Fig. 21).

The Seed Business

The seed trade is a specialized and highly technical business, with concerns engaged in many different branches and offering services of many degrees of merit. Most vegetable seed is bought by the planter rather than being saved or grown. In general, breeding and service about keep up to what planters demand and for which they are willing to pay. Seed houses have constantly advanced in breeding, production, and service. There are enough good houses that one need not take undue risk in buying from unreliable sources. This is especially important, as the merit or demerit of a sample of seed is not evident on inspection. Like insurance or banking, the seed business represents a trust relationship and is dependent upon the character of men, their ideals, integrity, and practices. Even good seed from an unreliable house is of only temporary value, for the buyer does not know that he can get the same value again.

Seed houses may engage in any or all of the following services: (1) Breeding, (2) growing, (3) wholesale dealing, (4) importing, and (5) distributing (merchants serving commercial or home planters or both). They may handle but one kind of seed or they may handle all kinds and other merchandise besides. There is some confusion in use of the term "wholesale," as it may be applied to transactions among seed growers and merchants, or it may be applied to sales to planters who grow vegetables to sell.

IMPROVING AND MAINTAINING STOCKS. New varieties and strains arise by discovery of a plant of distinct type among others, by mass selection for better type, or by crossing and selection. For a general understanding of breeding vegetable plants, refer to Chapter 4. In recent years, an increasing number of improvements have come

through definite efforts toward a preconceived type, crossing and selecting until the desired result is attained, and fixing the type through pure-line breeding. Many experimental stations and seed houses employ highly trained scientists in this work.

Intensive breeding work yields stock seed in small quantities. A good house treasures its stock seed, reproducing it with great care under selection (choosing the best plants) and roguing (discarding off-type plants) from year to year. Good market seed is faithfully rogued, but if stock seed has been well bred only a few plants need to be discarded. From this stock seed, market seed is grown in especially suitable regions. Cheap seed may represent simple crop growing with little attention to keeping the stock true, to say nothing of improving it.

Seed producers must not only improve their stocks, but also be thoroughly acquainted with the merit of these stocks. Dealers also should know the qualities of the stocks they handle. To this end, special trial grounds are often maintained. Some houses depend upon observation in the fields of their customers. A combination of both methods is best, each making its own contributions.

Some seedsmen, for certain kinds at least, buy seed a year in advance and carefully test a sample from the actual lot before selling for planting. Such seed is properly called proved or proven seed, and the term should not be applied to seed that has merely been tested for germination or to seed supposed to be of the same stock as a tested sample.

NON-WARRANTY CLAUSE. The non-warranty clause as adopted by the American Seed Trade Association, is as follows: "We give no warranty, expressed or implied, as to description, purity, productiveness, or any other matter of any seeds or bulbs we send out, and we will not be in any way responsible for the crop. If the purchaser does not accept the goods on these terms, they are at once to be returned."

Most seedsmen use this clause or words to the same effect. While this seems harsh toward the buyer, a moment's thought reveals the fact that failure may be due to many causes other than poor seed, and that it is usually impossible to tell what cause is responsible. If the seedsman were to assume all these risks in addition to the risks of error on his own part or on the part of those upon whom he depends, the cost would be excessive. At the same time, the non-warranty clause should not afford occasion for the seedsman to dodge responsibility for the properties of seed for which he may justly be held respon-

FIG. 22. Cantaloupe seed in drying racks.

sible. Good seed houses are careful, and when the fault is theirs, substantial adjustments often are made. The clause is deemed necessary to protect against imposition. There are plenty of good seedsmen from whom the seed buyer can obtain good seed and good service on the usual non-warranty terms.

WHERE SEED COMES FROM. Vegetable seed may be bred in many climates. Market crops produced by multiplying well-bred stock seeds are grown where soil, climate, and economic conditions are favorable. Pea- and bean-seed production moved from East to West, largely because of disease and poor conditions for curing in the East. A large part of the cantaloupe and cucumber seed comes from the Rocky Ford section of Colorado (Fig. 22). Denmark is still a center for good cabbage seed, and radish and spinach are obtained largely from Holland. The proportion of our seed grown in the United States has greatly increased in 20 years, largely because our seed growers have learned to make a good job of it. The skill and care of seedsmen is far more important for quality of seed than is the place of production.

Buying Seed

Judicious buying of seed calls for utmost care, and emphasis should be placed on the ultimate value of the crop rather than on the initial cost

of the seed. In general, one should buy from seedsmen of established reputation who cater to commercial planters, that is, from houses accustomed to serving critical trade. One may well inquire among neighbors and at meetings to learn what houses hold reputations for quality of seed, dependability, and good service. Then one's own experience becomes a valuable guide.

CATALOGUES. The seed catalogue is a fascinating book, and none would care for a drab and colorless offering of goods. A good merchant is enthusiastic after he has expended cash and care to get the best. We need, however, to learn which houses are given to extravagant claims and which keep praise and merit fairly abreast. One may readily distinguish between statements of opinion, "The best we have ever seen," and statements of fact, "A week earlier than Marglobe." Catalogues of the more dependable houses are nowadays giving a larger measure of actual facts, telling what a variety is like. Pictures are less extravagant and more informing, though it is the cataloguers' business to show fine specimens of true type. Unfortunately, there are too many catalogues that are less than candid in their statements.

SALESMEN. Commercial planters buy much of their seed through traveling salesmen. Fear them not, ask clear-cut questions, expect clear-cut answers. The better ones will be found helpful aids and full of valuable information. Who has better chance to learn the tricks of good production? Cultivation of cordial business relations with seedsmen is profitable. With mutual confidence, a good salesman will even whisper, "Lay off that stock this year. We'll have a better next." If the salesman does you wrong, let him stay outside your gate, but there is much to be gained by meeting a good man openly and fairly.

KNOWN ORIGIN. The planter has as much right to assurance about his seed as to know the name of the car he buys. Many seedsmen are not yet ready to tell where they get their seed, but, even in these cases, the buyer should insist on definite stock numbers and assurance that will enable him to buy seed of the same parentage next year or be told it is not available. In the meantime, wholesale producers and breeders are advertising more widely, retailers are realizing it is well to feature the name of a good seed grower, and the idea of known origin is gradually spreading. The planter may profitably learn who are breeders and producers of good seed and ask for their products. The salesman may mention some other source. Then find out if it ranks with the best. Thus knowledge of buying is built up.

Some houses now stamp stock numbers on all packages and most good houses keep record of stock numbers of lots delivered. The planter who wants it may have assurance as to the identity of the stocks he plants.

BUYING IN ADVANCE. Many planters buy seed a year ahead and plant a sample for careful trial. Even though the lot proves bad and is discarded, the loss is but a fraction of the value of a crop. This practice is feasible only with suitable climate and facilities for storage of the seed. Onions, parsnips, and sweet corn are likely to decline in germination too rapidly for this plan, and the cost per acre of seed of peas and beans is too heavy. Growers of celery and cabbage follow the scheme with great satisfaction, and development of better knowledge of seed storage may permit wider observance in the South.

COST OF GOOD SEED. As already pointed out, the cost of seed for an acre of most crops is but a small fraction of expected returns. Cheap seed, if poor, may cost many dollars per acre. At the same time, a high price does not necessarily mean good seed and often very good seed is to be had at moderate, though seldom at very low, prices. Buying on bids alone and seeking the cheapest are to be utterly condemned, unless definite specifications regarding purity, vitality, and trueness to the desired type are met by the bidder.

Growing Seed

Growing seed to sell is an alluring business and offers satisfying rewards to the man who loves it and can give it the exacting care it requires.

The man who grows his own seed is assured of its origin and parentage. He can select to his own ideal, to suit his own lands and markets, and he comes to understand and enjoy his crop and to profit in its management as few are able to do. His sacrifices are serious. He must establish his ideal and not waver in selection, and must be the soul of patience. Much work must be done at the right time, whether it is convenient or not, and the rush of selection or curing may coincide with the rush of marketing. Careful study of the crop in hand and of breeding in general is required.

Success, however, may bring others to the door to buy, and some very satisfactory seed businesses have been started in this way.

Casual seed saving as a matter of cutting production cost is likely to be disappointing.

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MANAGING SOILS AND FERTILIZING

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In the South it is necessary to give special attention to soil conservation and the maintenance of the proper amounts of available nutrients in the soil. There is little frost action to aid in the liberation of nutrients. Furthermore, nutrients leach out of unfrozen soils and the danger of erosion is very great in regions of heavy rainfall and little snow or frost protection. Improper soil management is one of the most common controllable causes for failure in vegetable production in the South.

Choosing Soils for Vegetables

PHYSICAL REQUIREMENTS. For early crops, where earliness is of more importance than total yield, sandy soils and sandy loams are best. These soils are well aerated, drying out and warming up rapidly in the spring. They are often low in nutrients and moisture retention, but moisture is usually excessive in the spring anyway.

Where large yields are more important than earliness and moisture is likely to become limited, silt loams, clay loams, and muck soils are best. They usually contain considerable reserve food material and retain moisture well. By proper soil management, these food reserves may be made available. If not worked while wet, they are fairly loose and friable, which is necessary for vegetable crops. Clays and heavy soils are not well adapted to vegetable crops, because of poor aeration and consequent poor nutrient liberation and root growth.

CHEMICAL REQUIREMENTS. Soils must contain large amounts of the bulk nutrients, nitrogen and phosphorus, in readily available form and in the right proportion for the various types of vegetables. Each vegetable requires nutrients in certain ratios for best results, as will be discussed later. Moderate amounts of the nutrients which are largely catalytic and corrective, including potassium, magnesium, calcium, sulfur, and iron, are required to be present in available form. Traces of several other elements have recently been found essential, but, as a rule, are present in sufficient amounts in normal soils.

The reaction of the soil should be such that favorable amounts of nutrients are kept available to the plant, and at the same time, the reaction should not cause toxic amounts of any element to be brought into solution.

BACTERIOLOGICAL REQUIREMENTS. Conditions in a soil should favor the growth of certain bacteria, as well as the plant itself. Nitrifying organisms make nitrogen available and organisms which decompose organic matter favor the liberation of other elements through the liberation of carbon dioxide and other compounds. Soil conditions best for the plant usually are best for these organisms as well.

Conserving the Soil

TERRACING. A vegetable gardener should select soils which are level enough to eliminate the necessity of using drastic conservation measures, and most vegetable plots are located on such land. In some instances, however, conditions necessitate the use of strip crops, terracing, and gully control (Fig. 23).

Very Steep to Moderate Grades. If land of steep or moderate grade is to be satisfactorily used for vegetables, it will have to be terraced

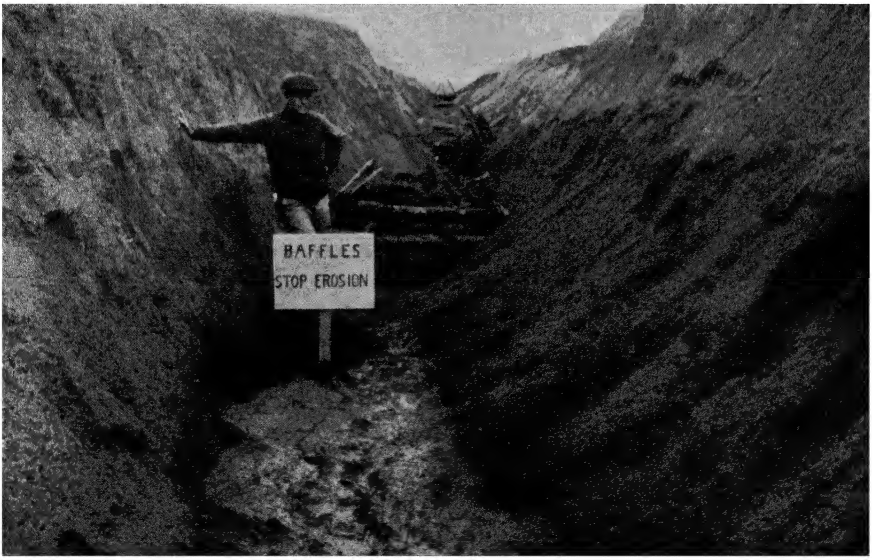

FIG. 23. One method of gully-control. Black locust trees may be planted in the soil which collects above the baffles. The tree roots will hold the soil when the baffles decay.

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FIG. 24. A standard broad-base terrace, 22 feet wide and 18 inches high, with a grade ranging from nothing to 2 inches per 100 feet.

(Fig. 24). As the grade becomes less, forms of terraces may be used which do not interfere very much with cultivation. Terraces prevent erosion, leaching, and excessive moisture run-off.

Slight Grade. Land of slight grade is usually farmed with no provision for erosion control. Sheet erosion may go on unobserved for years, taking off the top and most valuable soil layers (Fig. 25). Gullies finally form but usually do not form until much loss has occurred. Contour cultivation and strip cropping usually control erosion on this type of land, although wide terracing is often advisable. All gullies should be widened and covered with tough grass sods.

Contour cultivation merely means running the rows with the contour. This necessitates some inconvenience, since the rows will be curved and short rows may result, but it is worth the trouble in moisture and soil conservation. This will be of little value on slopes of 5 per cent or above.

STRIP CROPPING. Strip cropping means the production of crops in long, alternate, variable-width strips placed cross-wise to the line of slope, approximately on the contour (Fig. 26). With truck crops, this would mean strips of vegetables, and strips of some kind of grass or

legume placed alternately. Strip cropping can be used on land of more than 5 per cent grade by using narrow strips conforming to the contour, but, on less sloping land, 200-foot strips can be used and these strips can be kept straighter.

DRAINING. Flat land may have no erosion problem, but it does have drainage and leaching problems. If the subsoil is loose and permits ready drainage, no provision for drainage need be made, but, if the subsoil is tight and water tends to stand on the land, a drainage system pays big dividends. Tile properly installed is best because it permits free use of the land, although open ditch drainage is better than none. Care must be taken to prevent over-drainage because excessive leaching and lack of moisture may result.

Leaching is greatest during periods when the land is not in use, especially in the winter, and during these periods some sort of cover crop should be used to absorb nutrients as they are liberated and to hold them for use by the next crop.

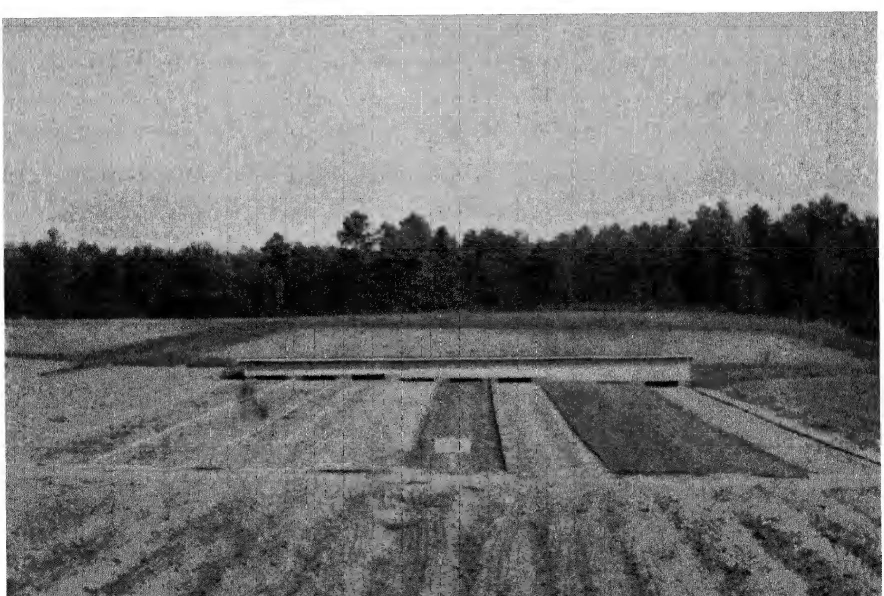

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FIG. 25. Accurate methods have been devised to measure erosion and leaching. The hundredth-acre plots shown above contain different crops, are separated by metal strips extending 15 inches into the ground, and drain into separate vats under the shed. The run-off, both soil and water, can be measured and computed on the acre basis.

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FIG. 26. Oats in strips between sweet corn satisfactorily controls erosion.

Preparing the Soil

BREAKING. Land should be loosened 6 to 8 inches for vegetables. If the soil has never been plowed more than 6 inches, care should be taken to bring up only about an inch of subsoil at a time, especially if the subsoil is heavy in nature.

Fall plowing has advantages in regions of winter freezing, but in the South its value is questionable, because of leaching and erosion of sloping soils which do not freeze much in the winter. However, if level heavy soils are plowed deeply, especially if a covering of coarse organic matter is turned under, the losses from leaching and erosion are not so great, and probably will be more than offset by the following advantages: (1) Improved physical conditions, resulting from alternate wetting and drying and light freezing; (2) reduction in insects, because of exposure to the weather; (3) rotting of organic materials in contact with the soil, thereby increasing the humus and liberating nutrients; and (4) relieving the pressure of spring work by making possible the working of the soil earlier in the spring.

Spring plowing should not be done too far in advance of planting unless heavy cover crops are turned under. Special care should be used

to avoid working the soil when it is too wet. If the soil crumbles readily after being pressed in the hand, it is dry enough to plow; but if it retains its form, the land is too wet for breaking.

FINISHING. Plowed land must be disked well, usually in both directions, before planting, as it is very essential to have a fine seedbed for most vegetables. A plank drag and Meeker harrow are commonly used to follow the diskings.

ROTARY TILLAGE. A new German method for preparing fine seedbeds consists of a power-driven revolving drum of springs and tines which, in one operation, makes a fine loose seedbed 8 inches deep. It is gaining in favor for preparing land for small seeds, such as carrots, and for rapid setting of vegetable plants.

Choosing the Soil Reaction

ADJUSTING SOIL REACTION. The proper soil reaction depends more on the nature of the soil than it does on the peculiar reaction requirements of the crop to be grown. If the proper amounts and ratios of nutrients for the crop are maintained and no compounds are allowed to be present in toxic concentrations, it makes little difference to the crop what the reaction is as long as it is in the growth range of *p*H 5 to *p*H 8 (Table 6). The reaction, however, greatly varies the nutrient balance and toxic conditions in each soil type, and it is very difficult to maintain the balance in an alkaline soil.

TABLE 6. *p*H AND CORRESPONDING SOIL REACTION [1]

*p*H	Soil Reaction	*p*H	Soil Reaction
4.5	Very acid	7.0	Neutral
5.0	Acid	7.25	Slightly alkaline [2]
5.5	Medium acid	7.5	Medium alkaline
6.0	Slightly acid	7.75	Strongly alkaline
6.5	Very slightly acid	8.0	Very strongly alkaline

[1] *p*H represents the degree of active acidity and alkalinity (not total acidity and alkalinity) in a soil. The scale used to indicate the degree sets the value 7.07 as the neutral point or this point is the *p*H of pure water (the active acidity or alkalinity of water). With this as the starting point, the value for acidity is anything less — down to nothing; and the value for alkalinity is anything greater — up to 14.14. The reasons for this scale and these limits require an understanding of logarithms, normal solutions, and ionization.

[2] Gradation is less on the alkaline side than on the acid side as there are 2.5 units on the acid side and only one unit on the alkaline side, which are within the limits of plant growth.

When the average of many soil types is taken, vegetable crops seem to fall into certain classes as to *p*H preference, because of certain nutrient preferences and toxic tolerances. Zimmerley classifies certain vegetables as to reaction response in eastern Virginia (Table 7). This grouping is fairly representative, although other authorities differ somewhat in their classification. It is clearly a matter of varying effect of reaction on the elements in different soil types.

TABLE 7. GROUPING OF VEGETABLES ACCORDING TO *p*H RANGE FOR SATISFACTORY GROWTH

*p*H 6.0 TO 6.5	*p*H 5.5 TO 6.5	*p*H 5.2 TO 6.5	*p*H 4.8 TO 5.2
Spinach	Lettuce	Carrot	Potato
Beet	Pea	Sweet potato	
Cantaloupe	Snap bean	Large lima bean	
Bush lima bean	Cucumber	Tomato	
	Cabbage	Sweet corn	

Controlling Soil Reaction

DETERMINING THE NEED OF LIME. Use should be made of soil reaction kits which indicate the approximate *p*H of soils. Too much confidence, however, should not be placed on the various lime requirement tests, as they are usually adapted to legume crop rotations in general farming, and may not be indicative of vegetable crop needs.

If reaction tests indicate rather strong acidity, it is advisable to apply several rates of lime on a few small sections of land before liming the entire farm, as liming is not universally beneficial to vegetables, even on acid soils. If lime is found to pay on the particular crops which are to be grown on these sections, it may be used more freely.

APPLYING LIME. If lime is needed for quick action, the hydrated form can be applied to plowed land before disking. However, it is less dangerous and usually cheaper to apply ground limestone several months before growing the crop. Lime should be mixed well in the top 3 to 4 inches of soil. A commercial lime spreader is best for making the application, although a shovel may be used for small areas. A grain drill can be used, when light applications are to be made.

The rate of application depends on the type of soil, degree of reaction present, reaction desired, and the form of lime. Hester has shown that less lime is needed to cause change at high acidity than at low acidity.

His results showing this and the variation in requirement because of soil types are given in Table 8.

TABLE 8. LIMING RECOMMENDATIONS FOR SOILS IN EASTERN VIRGINIA

Range in Acidity	Pounds of CaO or MgO Equivalent per Acre to Change Soil *p*H [1]		
	Sandy	Sandy loam	Loamy soil
From *p*H 5.5 to *p*H 6.5	1,500	2,000	3,000
From *p*H 4.5 to *p*H 5.5	1,000	1,500	2,000

[1] If soils have a high organic content, more lime will be required to change the reaction than is indicated in the table.

It is best to start with low amounts (500 to 1,000 pounds of ground limestone per acre) and build up as yield and soil reaction tests indicate the need. The amounts of rock or quick lime (CaO), given in Table 8 should be multiplied by 1.3 to get equivalent amounts of hydrated lime ($Ca(OH)_2$) or by 1.8 to secure equivalent amounts of ground limestone ($CaCO_3$).

SOURCES. Dolomitic limestone contains magnesium as well as calcium, and it usually is best to secure limestone with some magnesium present; but too large amounts of magnesium are much more likely to cause harmful effects than calcium. Marls are a good source of limestone, and often give more returns per ton than ground limestone.

Maintaining Organic Matter

VALUES OF ORGANIC MATTER. Organic matter increases the porosity of heavy soils, which, in turn, causes increased water absorption and lessens water run-off, leaching, and erosion. The increased porosity also causes greater aeration, which favors the right kind of bacteria for nutrient liberation and direct chemical oxidation processes. On the other hand, organic matter will help to keep sandy soils from becoming too porous. The black color imparted by organic matter causes heat absorption, and the non-conductive nature of organic matter lessens heat radiation, both aiding the soil to warm up quickly, provided that the amount of water present is not excessive. The use of fresh organic matter too close to planting time of vegetables may cause (1) burning from rapid decomposition, (2) interference in water movement by forming excessively aerated layers and pockets, (3) locking of available

nitrogen by decomposition bacteria, (4) mechanical interference to plowing and cultivation, and (5) formation of toxic organic compounds, under certain anaerobic and non-colloidal conditions. If air and moisture be favorable and sufficient time be allowed, these difficulties will be overcome. Addition of lime and nitrate will aid in cases of nitrogen deficiency.

MAINTAINING ORGANIC MATTER BY ANIMAL MANURES. If animal manure can be secured cheaply, it is the best material for maintaining the organic content of the soil as well as a good source of nitrogen. When used, however, it is necessary to watch and maintain the phosphorus supply, since animal manure is usually low in phosphorus. Although fresh and strawy manures may cause damage if used too near planting time, they have the following advantage over rotted manure if applied far enough in advance of the crop: (1) Less nutrients are lost through decomposition and leaching, (2) more bacteria are added to the soil, (3) greater source of energy is provided for bacteria, resulting in (4) a much greater liberation of nutrients through solvent action, and (5) greater buffer effects. Decomposed manure which has been well cared for, however, is very valuable because it (1) can be applied just ahead of the crop; (2) is higher in percentage of total nutrients, if excessive leaching has been stopped; (3) is much higher in readily available nutrients; (4) has no burning effects; (5) produces more uniform action throughout the soil mass; (6) usually contains more phosphorus in relation to the nitrogen, resulting in a more balanced nutrient supply; (7) destroys or reduces weed seed germination; and (8) offers less mechanical interference. Usually, it is advantageous to use fresh strawy manure in the fall and well rotted manure in the spring.

In many cases, natural manures are rather expensive and difficult to secure, especially for a market gardener who keeps no livestock. Several processes have been found for converting organic materials, such as straw or cornstalks, into manure by adding nitrogen and phosphorus fertilizers along with lime and water. The Rothamsted Station in England first suggested the method. The Missouri Experiment Station has secured good results with straw, and the Iowa Station with cornstalks. This artificial process is practical on small areas of intensive gardening; but for large areas, it is generally more practical to grow a green manure crop and turn it under. Uncertainty of sufficient rain to rot the straw and the cost of collecting enough organic matter make

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FIG. 27. A heavy green-manure crop of Laredo soybeans being turned under in July

artificial manures expensive to vegetable gardeners who do not grow cereal crops or have shredders available.

The rate of manurial application varies greatly with the land, the crop, the cost of manure, and the kind of manure. Often 30 to 40 tons, especially of the strawy type of cow manure, are not excessive. Many experiment stations have shown that light applications supplemented by commercial fertilizers, especially phosphate, are more economical than manure alone. Chicken manure should be put on very lightly, and far enough from the plants to avoid burning. Broadcasting of manure is best, except in the case of widely-spaced hills of cucurbits.

MAINTAINING ORGANIC MATTER BY GREEN MANURES. For the vegetable gardener with plenty of relatively cheap land, one of the cheapest and most efficient ways to secure nitrogen and organic matter is through the use of legumes (Fig. 27). However, for a gardener located on a limited area of expensive land, the use of legumes may not be advisable, and he would likely profit by the use of manure, winter cover crops, and commercial fertilizers.

Green vegetation incorporated into the soil rots much more quickly

than dry material. When vegetation is allowed to dry out before it is turned under, the nutrients are transformed to less available forms. Long exposure to oxidation in the weather may result in a loss of nitrogen.

Besides increasing the organic content and adding air nitrogen to the soil, legumes (1) conserve soluble nutrients, (2) improve the subsoil by penetrating it and incorporating organic materials in it, (3) make mineral nutrients available, (4) transfer them to the top soil, (5) favor bacterial growth, and (6) reduce erosion.

When choosing a legume, the adaptation to soil and climate should be considered first. After this, the amount of readily incorporated vegetation produced in the time available should determine the choice. For the South, soybeans and cowpeas are well adapted to growth in the summer and produce large amounts of organic matter in a short time. Leading varieties of cowpeas include Whippoorwill, New Era, and Crowder. The Brabham and Iron are good varieties where nematode resistance is important. Laredo, Mamloxi, Mammoth Brown, and Otootan are desirable soybean varieties.

For certain types of land, lespedeza is becoming very popular. The Korean type is preferred in the upper South, while the common or Kobe type is best in the central and southern parts of the South. Lespedeza grows on relatively poor and acid land, reseeds itself, leaves the ground in good physical condition, and is naturally inoculated on most soils. Crimson clover makes a good catch crop for sandy soils in those parts of the South where it does not become excessively hot and dry. It is easily killed by cold, but will winter in most of the southern states. For penetration of subsoils and producing large amounts of organic material, the annual sweet clover is grown in the South, and the biennial white type is grown further north. It takes longer to grow this crop and it is not so easily incorporated as are cowpeas, soybeans, and crimson and bur clovers.

Hairy vetch, Austrian peas, and bur clover are satisfactory winter cover crops under most southern conditions, if they are properly planted and inoculated.

For land which will not naturally inoculate the legume to be grown, it is necessary to inoculate the seed with natural inoculation from a soil known to contain the organism or by artificial inoculating material purchased from a seed firm or other source.

Non-legumes have all the values of legumes with the exception that they do not actually add atmospheric nitrogen to the soil. The grasses are used as cover crops because they are easily started and form a non-

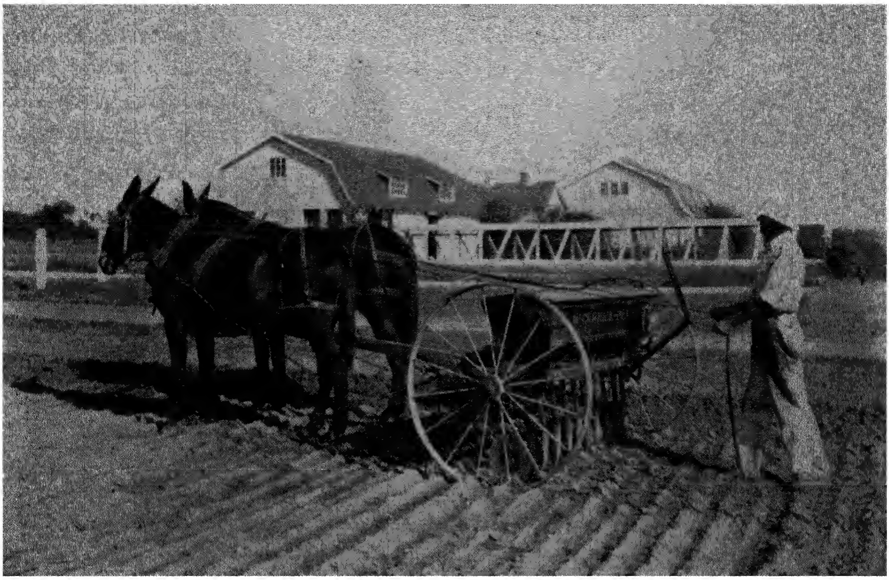

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FIG. 28. A combination seed and fertilizer drill is a valuable piece of farm equipment.

erosive surface which quickly prevents leaching. Rye is almost universally used as a winter cover by general farmers, but there is some question as to its value for the southern vegetable gardener, because it is difficult to kill and hinders early gardening. In many cases in the southern states, vegetables are grown in the late fall and early spring, and cool season crops are grown during January and February so that rye would be of little value for such crops. Oats make a good cover if sown in the fall, but this crop is subject to winter injury.

Various methods are employed in planting cover crops. The hand-broadcast method is uncertain and requires more seed for satisfactory coverage. A seed drill has the advantage of planting at uniform depth and rate, and saves unnecessary operations (Fig. 28).

Using Commercial Fertilizers

IMPORTANCE OF COMMERCIAL FERTILIZERS. Commercial fertilizers are added to a soil with the particular purpose of directly increasing the amounts of nutrients available to plants. They are not added to improve physical conditions nor to make soil reserves available. Organic matter and lime do much more than simply add nutrients and,

TABLE 9. THE COMPOSITION OF FERTILIZERS[1]

Fertilizer	Nitrogen (N) Per Cent	Phosphorus Pentoxide (P_2O_5) Per Cent	Potash (K_2O) Per Cent	Total Plant Food Per Cent
Organic plant foods				
Nitrogen only, or chiefly nitrogen				
Dried blood	12.0–13.0	0	0	12.0–13.0
Garbage tankage	2.0–10.0	0	0	2.0–10.0
Peat or muck	0.8–4.0	0	0	0.8–4.0
Chiefly nitrogen and phosphorus				
Tankage	6.0–10.0	4.0–14.0	0	10.0–24.0
Bone meal (raw)	3.0–4.0	18.0–20.0	0	21.0–24.0
Bone meal (steamed)	3.0–3.5	21.0–25.0	0	24.0–28.5
Fish scrap	8.0–11.0	6.0–12.0	0	14.0–23.0
Peruvian guano	6.0–10.0	8.0–14.0	0	14.0–24.0
Chiefly nitrogen and potassium				
Tobacco stems	1.5–3.5	0	4.0–9.0	5.5–12.5
Nitrogen, phosphorus, and potassium				
Horse manure (rotted)	0.8	0.6	1.4	2.8
Cow manure (in yard without litter)	0.3	0.3	0.1	0.7
Sheep manure (dried)	1.5–2.1	1.0–1.4	1.3–2.8	3.8–6.3
Hen manure (dried)	1.0–2.0	0.4–2.2	0.5–1.1	1.9–5.3
Goat manure (dried)	1.3–2.5	1.4–1.5	1.9–2.9	4.6–6.9
Leaves (composted)	0.8	0.2–0.3	0.3–0.4	1.3–1.5
Rabbit manure	2.0	1.3	1.2	4.5
Chemical plant foods				
Nitrogen only				
Calcium nitrate	15.5	0	0	15.5
Ammonium nitrate	35.0	0	0	35.0
Nitrate of soda	15.6	0	0	15.6
Sulfate of ammonia	20.0–20.5	0	0	20.0–20.5
Cyanamid	20.5–24.7	0	0	20.5–24.7
Urea	46.6	0	0	46.6
Phosphorus only				
Superphosphate	0	19.0–20.0	0	19.0–20.0
Acid phosphate (Florida)	0	14.0–17.0	0	14.0–17.0
Raw phosphate rock	0	32.0–37.0	0	32.0–37.0
Potassium only				
Kainite	0	0	12.0–13.0	12.0–13.0
Kelp ash	0	0	15.0–30.0	15.0–30.0
Muriate of potash (KCl)	0	0	50.5	50.5
Sulfate of potash	0	0	48.0–50.0	48.0–50.0
Carbonate of potash	0	0	15.0–50.0	15.0–50.0
Nitrogen and phosphorus				
Bone black	0.8–1.6	32.0–35.0	0	32.8–36.6
Ammonium phosphate	10.5–16.5	20.0–47.0	0	30.5–63.5
Nitrogen and potassium				
Nitrate of potash	12.0–14.0	0	44.0–46.0	56.0–60.0
Phosphorus and potassium				
Wood ashes	0	1.5–2.0	3.0–7.0	4.5–9.0

Calif. Ext. Serv. Cir. 53, 1933.

[1] Nitrogen is listed in percentage of nitrogen rather than ammonia, the phosphorus is listed in percentage of phosphorus pentoxide, and the potassium as potassium oxide. The reader will note that the total plant food does not represent the percentage of the three elements; however, the above total is often used and does indicate the total of fertilizer values to a limited extent.

for this reason, often produce better results than commercial fertilizers alone. However, manure, organic matter, or lime cannot be depended on to produce sufficiently available nutrients in many soils with low reserves; and even in fertile soils, organic materials and lime may cause improper nutrient ratios. Commercial fertilizers are necessary to furnish limiting elements in the most economical manner and to maintain proper ratios of the nutrients for the particular crop being grown. No soil, no matter how fertile, can provide the proper ratios for all types of vegetables; and, hence, the proper use of fertilizer is necessary on all soils on which various types of vegetables are to be grown.

CHEMICAL ELEMENTS ESSENTIAL TO GROWTH. Of the several essential elements, nitrogen, phosphorus, and potassium are the ones most generally lacking. The different elements are discussed below, and the composition of fertilizers is given in Table 9.

Nitrogen. Nitrogen builds up the vegetative portions of the plant, producing large green leaves. It is also necessary for filling out fruits, and if it is present in large amounts in relation to other elements, it will cause excessive vegetative growth and succulence.

Nitrogen fertilizers that leave an acid residue are ammonium sulfate, ammonium nitrate, and ammonium phosphate. Nitrogen fertilizers that leave an alkaline residue are sodium nitrate, calcium nitrate, potassium nitrate, and cyanamid.

Cottonseed meal, linseed meal, castor-oil meal, blood, tankage, fish tankage, guano, and urea are all organic and neutral in their effect on soil reaction. Nitrogen fertilizers should be used cautiously since there is danger of over vegetation or of the burning of seed or plants. The high cost of organic carriers of nitrogen and their slow availability (except urea) should be considered. The acid fertilizers should be used on nearly neutral to alkaline soils, while the alkaline fertilizers should be used on nearly neutral to acid soils. The neutral organic fertilizers can be used on either acid or alkaline soils but are used when slow availability is desired, the nitrates being immediately available and the ammonia salts being fairly rapidly available.

Phosphorus. Phosphorus is necessary for cell division and is especially essential in fruit and seed production. The plant will be stunted and the fruit will fail to set if phosphate is inadequate, especially if nitrogen is high. Phosphate also stimulates root production and seed storage.

Natural phosphate rocks and animal bones are the chief source of

phosphorus fertilizers. Both have to be treated with acid (usually sulfuric) to make the phosphorus available. Superphosphate fertilizers have recently been standardized to contain 20 per cent phosphorus pentoxide instead of 16 per cent. Higher analysis phosphatic fertilizers may be secured, but often are more expensive per unit of phosphorus.

The fixation tendency of soil towards phosphorus rarely allows a case in which phosphorus becomes excessive in relation to nitrogen or is toxic to seed plants. Less caution need be used in applying large amounts of phosphorus than is the case with nitrogen. Because of fixation, superphosphate should be applied in concentrated bands, and as nearly at the time the plant will use it as possible.

Potassium. Potassium is important in the formation and translocation of carbohydrates and, hence, is important to root and tuber crops and in the formation of large rigid stems as in celery and rhubarb. It is also important in disease resistance, protein formation, and cell division. It does not, however, form part of the cell tissue and is not a bulk nutrient as are nitrogen and phosphorus, and is not needed in such large amounts.

Muriate and sulfate of potash, kainite, and wood ashes are the main sources of potassium. Most mineral soils contain sufficient amounts of potassium for all crops except those mentioned above, although most muck and sandy soils are deficient. Excess does little harm unless it becomes concentrated enough to cause ex-osmosis, but the cost of the excess results in financial loss to the grower.

Calcium. The main function of calcium seems to be corrective in nature. It combines with toxic acids developed in the life processes of the plant, and aids in overcoming the effects of too large amounts of other elements, such as magnesium. Calcium seems to be necessary in the normal absorption of all nutrients. It is rarely limiting for plant use, but it is needed in soil reaction control. Rather large amounts do no direct injury to the plant, but indirectly the hydroxide or carbonate may be injurious by making certain elements unavailable.

Other Elements. Space will not permit discussion of other elements and therefore a few of the more important ones with their main function are merely listed as follows: (1) Magnesium, link in chlorophyll molecule, fat, and oil formation; (2) sulfur, essential to certain proteins in crucifers and onions; (3) iron, catalytic agent in chlorophyll action; and (4) manganese, oxidation and reduction reactions. Boron, copper, and zinc also have been found to be essential, although their functions are unknown.

Determining Fertilizer Analysis, Formula, and Ratio

ANALYSIS. Commercial fertilizers should always bear a tag which gives the analysis, such as, 3–8–6 and 5–10–5. The first figure means 3 per cent nitrogen; the second, 8 per cent available phosphorus pentoxide; and the third, 6 per cent water-soluble potassium oxide.

The above examples are low-analysis fertilizers, but there are now available high-analysis fertilizers, such as 6–16–12, which contain exactly twice the quantity of nutrients as 3–8–6. In buying fertilizer, attention should be paid to the price per fertilizer unit[1] instead of the price per ton. Fifteen per cent nitrate of soda at $40 a ton makes each pound of nitrogen cost about 13 cents; twenty per cent superphosphate at $20 a ton makes each pound of phosphorus cost 5 cents a pound; and 50 per cent muriate of potash at $40 a ton makes each pound of potash cost 4 cents a pound. This would mean that a 3–8–6 should cost $20.60 per ton. One could then afford to pay at least $41.20 a ton for a 6–16–12 fertilizer, or $61.80 for a 9–24–18. In fact, somewhat more than this could be paid because transportation and application costs are less per unit of nutrients in high analysis fertilizers. The high analysis fertilizers are a little more difficult to distribute evenly, and are more likely to burn on contact with seeds or plants; but, other than this, they are as good as the low analysis fertilizers. Recent laws in some of the states require that at least 20 units of fertilizer be present, hence a 3–8–6 could no longer be sold in such a state, since it totals only 17 units.

FORMULA. The formula tells what kind of materials are used to make the units of available fertilizers. For example, a standard vegetable fertilizer may have an analysis of 5–10–5. This tells how much of each element there is available, but does not give the source of elements. The formula should be given, reading as follows: 2½ per cent nitrogen as 15 per cent sodium nitrate, 2½ per cent nitrogen as 20 per cent ammonium sulfate; 10 per cent phosphorus pentoxide as 20 per cent superphosphate; and 5 per cent potassium oxide as 48 per cent potassium chloride. This tells what the source is as well as the amount present. A buyer of fertilizers should demand the formula and note the rate of availability of the nitrogen, and the effect the compounds may have on soil reaction. Such physical factors as freedom from caking and ease of drilling are also important. The use of highly concentrated chemicals

[1] A fertilizer unit equals 1 pound of the actual element. For example, 100 pounds of 15 per cent nitrate of soda contains 15 units of nitrogen (N); 100 pounds of 20 per cent superphosphate contains 20 units of phosphorus pentoxide (P_2O_5); and 100 pounds of 48 per cent muriate of potash contains 48 units of potassium oxide (K_2O).

may not be desirable because mineral impurities in low analysis fertilizers may be of value, especially on sandy and muck soils.

RATIO. Fertilizer ratio differs from analysis in that it expresses the fertilizer in the ratio of one element to another, usually in terms of nitrogen. For instance, 5–10–5 is the analysis, but 1–2–1 is the ratio. Therefore, ratio does not tell how much of each element there is but, in this case, it simply says there is twice as much phosphorus pentoxide as nitrogen and the same amount of potassium oxide as nitrogen. The proportion which the elements bear to each other in a fertilizer is very important, and this ratio depends on the time of application, the soil nutrients available to the plant, and the particular demands of the crop being grown.

Mixing Fertilizers

Although many growers buy their fertilizers already mixed, this does not mean that it is always best to do this. A good vegetable producer, as a rule, would be ahead to mix his own because he knows what is being used, can suit the mix to his own needs better, and furthermore, the cost will be considerably less. By applying the principles discussed in the preceding paragraphs, and using a little simple arithmetic, the mixing of fertilizers is very easy. Suppose a ton of 6–12–6 fertilizer is to be made. A part of the nitrogen is slowly available, and the fertilizer is to be used on a medium acid soil. Then 6 per cent of 2,000 pounds equals 120 pounds of nitrogen needed. Sixty pounds of this is to be available, so 15 per cent nitrate of soda may be used. Ammonium sulfate could be used if the soil were only slightly acid or alkaline. The nitrate of soda needed equals $\frac{60}{15} \times 100$ or 400 pounds. The remaining 60 pounds are to be slowly available and neutral, so 14 per cent dried blood will be used for this. The blood needed equals $\frac{60}{14} \times 100$ or 428 pounds. In a similar way we calculate the other ingredients needed with the following results:

		Pounds
Nitrate of soda	(15% N)	400
Dried blood	(14% N)	428
Superphosphate	(40% P_2O_5)	600
Muriate of potash	(50% K_2O)	240
		1,668
Filler		332
Total 6–12–6 fertilizer equals		2,000

The filler should be of some drying material. Sand or dry soil may be used, or low nitrogen organic materials are good. Of course, it is not necessary to use a filler, in which case a correspondingly smaller quantity

of the more concentrated fertilizer may be employed. Tankage (5 per cent N) is a good drier and may be used by reducing the dried blood and using the right proportion. Lime is sometimes used but should never be used with superphosphate or ammonium salts, due to fixation of phosphorus and liberation of ammonia to the air.

Determining Fertilizer Requirements

Experimental plots have been relied on in the past to show fertilizer needs, but each individual field has been receiving different treatments each year and it is often difficult to base recommendations from results on a similar soil type. For this reason, rapid chemical tests, both on the soil and plant, are coming into use. These tests should prove of special value to vegetable crops, since many of these crops are very exacting in their needs for proper amounts and ratios of nutrients to produce maximum yield and quality. Rapid soil tests have been used for some time but difficulties are encountered in determining actual availability of the nutrients to the various plants. Rapid plant tests on the mature stems and petioles of plants actually show the amounts of nutrients available and in what ratio they are present. They are especially well adapted to detect nutrient deficiencies. The Purdue, Virginia, and Kentucky experiment stations have done work on these methods of determining fertilizer requirements, and will supply methods upon request.

Fertilizer requirements for different vegetable crops are discussed under the special crop chapters.

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7

GROWING PLANTS, HARDENING, AND TRANSPLANTING

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Many vegetable-crop plants are commonly started in specially prepared beds and the young plants later transplanted into the field or garden. Cabbage, cauliflower, Brussels sprouts, celery, tomatoes, eggplants, peppers, sweet potato, and others are generally started in special beds in order to enable the grower to give them good care during the early stages of growth with a minimum of labor.

Plant Growing Structures

There are many advantages in starting plants in greenhouses, hotbeds, or cold frames, including (1) lengthening of the growing season; (2) producing an earlier crop, thereby getting the advantage of the early market; and (3) protecting the young plants against unfavorable weather conditions.

GREENHOUSES. Greenhouse construction and management are specialized subjects and are discussed here only from the standpoint of use by the market gardener and truck grower as an adjunct to outdoor gardening.

For the vegetable grower in the colder regions of the South, greenhouses are superior to hotbeds or cold frames for starting plants. Some of the advantages of greenhouses over other forcing structures are (1) better temperature control, (2) better regulation of ventilation and less danger of chilling the plants, (3) more convenient arrangement for work in caring for the plants.

When a greenhouse is to be used only for growing plants for transplanting, one cannot afford to build an expensive structure, since it is used for a short period each year. For this reason there is demand for small, inexpensive houses. Some of the greenhouse building firms are making a specialty of small, ready-cut greenhouses to meet this need. Many growers have built inexpensive frame structures and covered them with hotbed sash. Some of these houses are low structures with the eaves

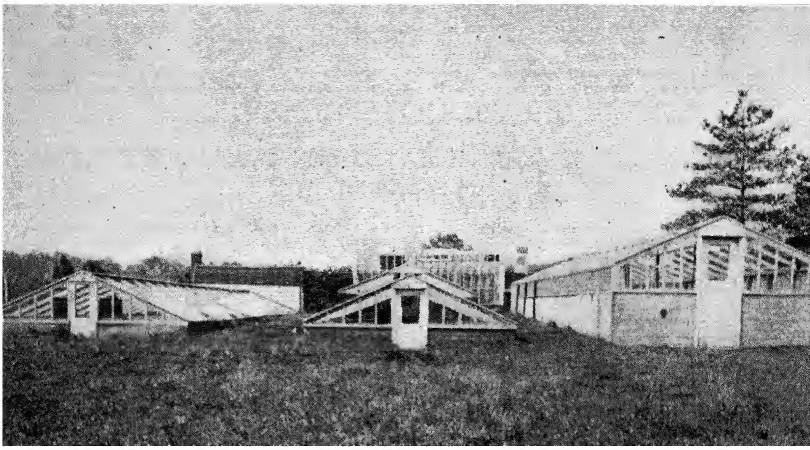

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FIG 29 Two types of sash greenhouses.

only a few inches above the ground level, while others have walls entirely above ground (Fig. 29). In the low houses, the walks between the beds are excavated to the depth of 2 or 3 feet and the beds or benches are near the ground level. This type is more easily heated than the high type, but is less convenient. The low type of structure is not satisfactory on poorly drained soil.

The high type of sash house has walls extending 2 to 4 or more feet above the surface of the ground. The walls may be of concrete, hollow tile, or wood up to the eave plate, or they may be part wood or concrete with glass above (Fig. 30). The only advantage of a sash house is its low cost, therefore, where considerable labor and money are expended on walls, framework, and heating system, it would seem wise to build a standard greenhouse rather than a sash house.

A sash house or other small greenhouse may be heated by hot air, hot water, or steam. Steam heat is not feasible unless a steam-heating system is used for other purposes. Hot-water heating is the most desirable and there are heaters on the market that are suitable for small greenhouses. Heating by means of hot air, carried through vitrified tile flues, is common in many sections

HOTBEDS. A hotbed is a specially prepared bed to which is supplied artificial heat. The heat may be supplied by fermenting horse manure, by hot air, hot water, steam, or by electricity.

Many hotbeds are heated by the fermentation of horse manure A

simple bed for temporary use may be made by setting a sash-covered frame on a flat pile of manure 2 to 4 feet high. The pile should be a foot or two wider and longer than the frame and it is desirable to bank manure up around the frame. The manure should be fresh and should contain about one-third straw. Before making the bed, the manure is piled in a low flat pile for a week or 10 days to allow it to begin to heat. After 3 or 4 days, the pile should be turned in order to have the fermentation take place uniformly through the pile and to prevent overheating in the interior. The frame is placed on the pile of manure and about 5 inches of good, friable soil is placed over the manure in the bed. The sash is then put in place. The temperature of the soil may rise to 125° F. or higher, but it will go down gradually and, when it reaches about 85° F., seed may be planted.

A better kind of manure-heated hotbed is one in which the fermenting manure is placed in a pit. The pit should be in a well-drained location, so that water will not collect in it and prevent fermentation of the manure. The width of the pit is usually about 6 feet which corresponds to the usual width of the frame, although the frame sometimes carries double rows of sash, sloping in opposite directions The depth of the

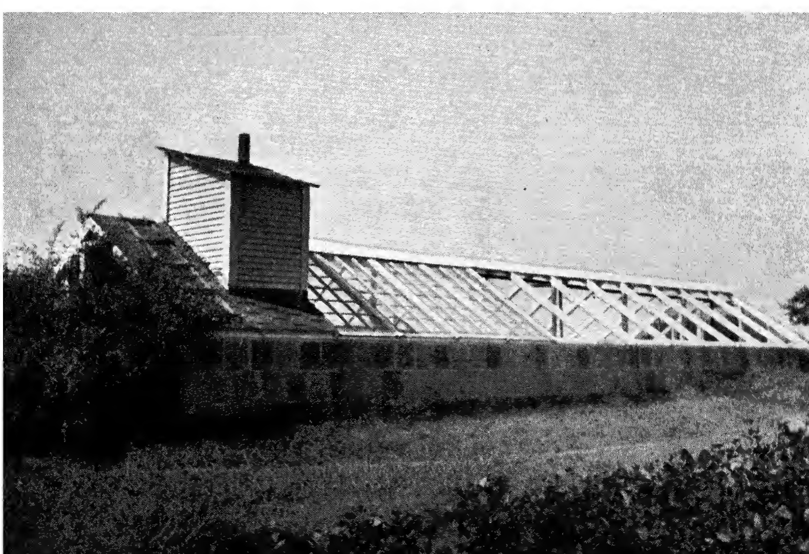

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FIG. 30. A hollow-tile sashhouse, showing method of placing sash. The hot water heater is installed in the front end.

pit is determined by the length of time the heat is needed. If the bed is to be used for a month only, a pit 15 to 18 inches deep is sufficient, but if it is to be used 2 months, it should be at least 2 feet deep and for a much longer period a depth of 3 feet is not too deep.

The frame of the hotbed may be made of wood or other building materials. Where wood is used, 2- by 4-inch lumber is used for posts at the corners and at intervals of 4 to 6 feet along the sides of the bed. Boards or planks are nailed to the posts on the inner side, and, when 1-inch boards are used, it is desirable to use a double layer. The frame usually extends to the bottom of the pit and it should extend 12 to 18 inches above the ground at the back and 6 to 12 inches at the front. The slope of the sash should be to the south or southeast, if possible. The standard hotbed sash is 3 by 6 feet. Every 3 feet there should be a crossbar or slide placed across the bed for the edges of the sash to rest upon. For these crossbars, 2- by 3-inch pieces are satisfactory and they should be mortised into the sides of the frames flush with the top of the sides. A ½-inch strip, nailed in the center of these bars to prevent binding of the sash, is an advantage and when this is used the crossbars need to be at least 3 feet and ½ inch apart. Durable wood, such as cedar, locust,

FIG. 31. Sash removed from hotbeds to show detail construction.

or chestnut for posts and cypress or chestnut for the frame, is desirable (Fig. 31).

After the hotbed frame is put in place, the manure, which has been prepared as previously mentioned, is forked into the bed in layers 5 or 6 inches deep. Each layer is packed moderately by tramping. Over the manure is placed a 6-inch layer of good, friable soil and then the sash is put in place. The heat generated by the manure will raise the temperature of the soil. No planting should be done until the soil temperature goes down to about 85° F. A soil thermometer should be used.

Hot water or steam may be used for heating the hotbed, but neither of these methods is practicable in a small bed, unless the system is used for other purposes. For either of these methods, the heating pipes may be placed in a pit beneath the floor of the bed or the flow pipe may be placed in the bed above the soil. Where the pipes are placed above the soil, the flow pipe may be located under the center of the ridge in double-width beds or near the top of the high side of single-width beds. In either case the returns are placed on the sides at a lower level than the flow pipe. The temperature can be regulated better in steam- or hot-water-heated beds than in manure-heated beds.

Beds heated by hot air are common in many sections. These are known as flue-heated beds, since the heated air is conducted from the fire box through flues placed beneath the bed. These are cheaper to construct than hot-water or steam-heated beds, but they are not so satisfactory. The fire box is built in a pit at one end of the bed and the heated air and fumes are conducted through tile flues which slope gently upward from the fire box to within a few feet of the farther end of the bed where they come to the surface under the bed. The fumes and air circulate under the floor of the bed and finally pass out through a chimney at one end. The size of tile to be used is determined by the size of the bed. A bed 12 by 60 feet should have two lines of 6-inch tiles, while one 12 by 30 feet may be heated satisfactorily with one line of 8-inch tiles.

ELECTRIC HOTBEDS. Electric hotbeds have come into use in recent years. A special heating cable is placed in a pit below the ground level. Some authorities recommend placing the cable on a layer of cinders to reduce loss of heat to the soil below. A layer of from 4 to 6 inches of soil is placed over the cable. A thermostat is used to control the temperature of the bed. The initial cost of the construction is relatively high, but the cost of labor in caring for beds heated by electricity is less than for steam or hot water. Garver and Vincent found relatively little

difference in cost of construction and heating between manure-heated and electric-heated hotbeds, when the cost was distributed over 3 years. In this case current cost three cents per kilowatt hour and manure for heating was figured at $12 per cord. The value of the spent manure should be considered in comparing cost of heating with manure and with electricity.

COLD FRAMES. Cold frames are much more important than hotbeds in most sections of the South. The main difference between hotbeds and cold frames is that hotbeds have some form of artificial heat while cold frames have not. Cold frames are used for (1) starting plants when some protection is needed; (2) hardening plants that have been started in greenhouses or hotbeds; and (3) growing crops such as lettuce, beets, parsley, and radishes, to maturity. If only a little protection is necessary, cold frames are satisfactory. In some sections of the South, as in the vicinity of Norfolk, Virginia, some crops, such as cucumbers, melons, beets, and others, are started in cold frames and, when the weather permits, the frames are removed and the crops receive field culture.

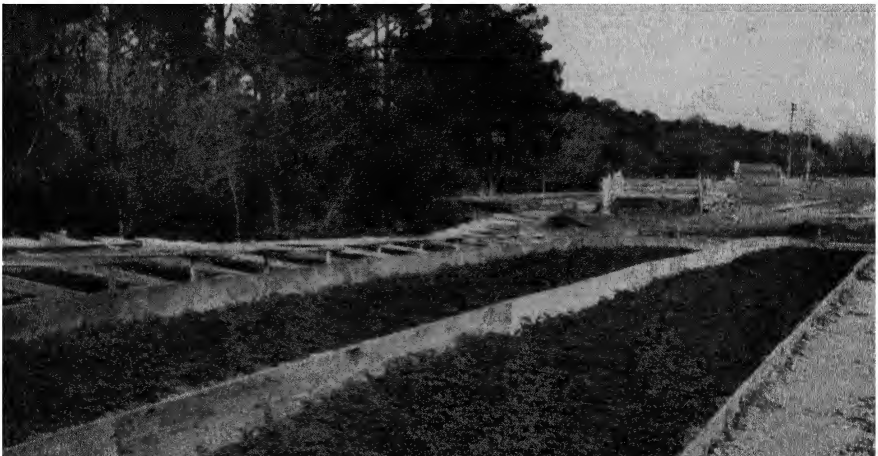

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FIG. 32. Cold frames are quite similar to hotbeds in construction, but are usually less permanent. These frames, which contain parsley, are cheap and movable.

Cold frames are constructed in very much the same way as hotbeds except that no pit is necessary for the former (Fig. 32). Permanent cold frames commonly are made of concrete, while temporary ones are built of boards or plank.

Cold frames are covered with glass sash, with canvas, or with other kinds of cloth. In the colder regions of the South, glass sash are desirable, but in mild regions, where the temperature permits removing the cover during most of the day, canvas or other cloth covering is satisfactory.

Growing Plants

Good plants are essential for successful vegetable growing. In order to have good plants for setting in the field, the grower must use good seed of the stock and variety suited to the conditions under which the crop is to be grown. He must use good soil for the plant bed and use care and judgment in the sowing of the seed and in the management of the bed.

PREPARING THE SOIL. A loose, friable soil should be used for the plant bed and a sandy-loam, well supplied with humus, meets the requirements. It is desirable to prepare a compost pile at least a year in advance of the time the soil is to be used. The best kind of compost is made by piling soil, containing a good sod, and manure in alternate layers, using one part of manure to 2 or 3 parts of soil according to need. If the soil is heavy, some sand should be added to the compost pile at the time it is made or at the time the soil is used. The pile should be built up with nearly straight sides and should be flat on top so that water will not run off. The heap should be chopped down and turned at least once before being used in order to mix the ingredients. Before the soil is used for the seedbed, it should be sifted through a coarse screen or run through a soil shredder.

SOWING SEED. Moisture, oxygen, and some degree of heat are necessary for germination. In specially prepared seedbeds, moisture is provided artificially when needed, but, to maintain uniform moisture, the soil must be of good texture. Heat is also supplied artificially when the plants are started in greenhouses or hotbeds.

The time of sowing seeds is determined largely by the time it is desired to set the plants in the field and the methods used in growing the plants. If plants are to be set directly from the seedbed to the field, less time is required than when they are to be transplanted prior to field setting. Many growers start plants too early and this results in stunted plants, or else they become too tall and "leggy."

Seeds are planted in flats or directly into the soil of the plant bed. Where greenhouses or hotbeds are used for starting plants, flats are fairly common and where flats are used they are filled with a good friable soil which should be well firmed to prevent too much settling. The flat is usually filled and the soil is pressed down with the hands along the edges and in the corners; then more soil is added and a straight edge is used to level off the surface even with the top of the flat. A board is then used to compact the soil and to leave it level and slightly below the top of the flat.

Most seeds are sown in rows in the flat or in the soil of the bed. When flats are used, the rows are spaced about 2 inches apart, but, when the seeds are sown in the soil of the hotbed, greenhouse bench, or in open beds, the space between the rows is greater, usually 3 to 6 inches. A simple method of measuring the distance between the rows and making the groove to receive the seed is to use a stick about 2 inches wide, $\frac{1}{4}$ to $\frac{1}{2}$ inch thick, and of a length to fit the flat. The edge of the stick is pressed into the soil to the depth desired. A similar method may be used also when the seed is to be planted in beds up to 6 feet wide, in which case the stick should be about 6 feet long and of the width desired. Where this method is used in flats all of the rows are made before sowing any seed. The seed is sown thinly and is covered by sifting fine soil over the rows and firming it lightly. A rakelike marker frequently is used for making rows for seed sowing in hotbeds, cold frames, or outdoor beds. For sowing seed on a large scale, a seed drill may be used to advantage. Small seed, such as celery seed, are sometimes sown broadcast and covered very lightly with fine soil or merely covered with burlap.

The depth of covering is governed largely by the size of seed and the texture of the soil. Very small seed should be covered lightly, if at all. Cabbage seed and others of similar size are covered to the depth of about $\frac{1}{4}$ inch when sown under protection, while beet seed should be covered $\frac{1}{2}$ inch under similar conditions. On heavy soil, the covering should be less than on light soil.

In the milder sections of the South, where winter production of vegetables is important, many plants must be started in the summer or early fall when some protection against high temperature and intense sunlight is needed. Some method of shading the seedbed usually is employed under these conditions. Lath, cloth of the type of cheese cloth or tobacco cloth, sacks, and straw mats are among the materials used for shading the young plants.

CARING FOR THE SEEDBED. Good, stocky plants are desired and to get them care must be given to watering and regulating the temperature and ventilation when greenhouses or other structures are used. As soon as the seeds are planted and covered, the seedbed should be carefully watered, preferably with a fine spray from a sprinkling can or with a fine rose on a garden hose. The seedbed should never be allowed to dry out and it should not be kept soaked. Until the plants are well established, the bed should be kept fairly moist but not wet. After the plants are well established, it is best to water thoroughly, preferably in the forenoon, and then to withhold water until the plants show the need of it. On cloudy, damp days ordinarily no water should be applied. Before the plants are taken up for planting in the field, the bed should be given a thorough soaking, so as to have as much soil as possible adhere to the roots.

When plants are grown in greenhouses or hotbeds, careful attention should be given to controlling the temperature and to ventilation. The temperature that should be maintained depends on the crops grown. Tomatoes, peppers, eggplants, and melons thrive best at a relatively high temperature, 60° to 70° F., while cabbage, lettuce, cauliflower, celery, and other cool-season crops will make better growth, although not so rapid, at temperatures 10 degrees lower. Slow, steady growth is preferable to rapid growth.

Ventilation aids in the control of temperature and of the humidity of the air. In greenhouses, ventilation is obtained by opening the ventilators, while in hotbeds and sash-covered cold frames, the sashes may be raised at one end or pulled down a short distance. On warm days the sash may be removed entirely. In ventilating during cool weather, the wind should not be allowed to strike the plants.

COMMERCIAL PLANT GROWING.[1] The production of vegetable plants for sale is of considerable importance in some regions of the South, especially in the Rio Grande Valley of Texas and in the Tifton-Valdosta section of Georgia. Other areas where plants are grown for sale on a fairly large scale include sections of northern Florida, and certain areas in South Carolina, Virginia, Louisiana, and Arkansas. These plants are shipped to northern states and to other sections of the South.

Certain sections of the Rio Grande Valley are devoted to direct field plantings of cabbage, onions, sweet potatoes, and tomatoes, while in eastern Texas, plantings of onions, cabbage, and tomatoes are started

[1] Prepared by J. G. Woodroof, Soil Conservation Service, Ga.

in hotbeds, transferred to cold frames, and then to the field. Most of the plants are shipped out of the state to northern markets in early spring. From approximately 15,000 acres in the state devoted to this use, the following number of plants are shipped annually: Sweet potatoes 750 million, tomatoes 100 million, cabbage 400 million, and onions 900 million. Of those mentioned, onion plant production is by far the most intensive, and in no other section of the country does the business reach so high a state of specialization. Both the soils and climate seem especially favorable.

The Tifton-Valdosta plant-growing area of south Georgia comprises about five counties that have built up, largely within the past decade, a production of more than 1,000 car loads of plants annually. The kind and approximate number of plants produced are: Sweet potato 100 million, tomato 500 million, cabbage 375 million, onion 22.5 million, pepper 2 million, eggplant 500 thousand, and cauliflower 100 thousand. While a great deal of the success of the industry, which is destined to become larger, is said to depend on trade secrets that have been developed by the 25 to 35 plant growers, it is known that early warm springs are very favorable to field planting of seed in this area and the Norfolk and Tifton series of soils of this section are admirably adapted to the production of plants.

Georgia-grown tomato plants are shipped in car load lots to the leading vegetable districts of New Jersey, New York, Indiana, and other states. Many of them are grown under contract for canners' associations. There is such a thorough understanding between the producers and consumers of the plants that there is less than 48 hours lapse between the time the plants are pulled and the time they are being set in the fields of Indiana or elsewhere. No refrigeration is used in the shipping cars.

Cabbage, onions, and sweet potato plants are grown in part under contract, while a large percentage of them are placed on the open market or shipped by local express or trucks. Eggplants and cauliflower plants are grown under contract for regular customers and seldom do they appear on the open market. The yields per acre of plants grown in the field with no heat or irrigation are approximately as follows: Tomato 100 thousand, cabbage 250 thousand, onion 750 thousand, pepper 250 thousand.

Transplanting

Plants that are started in greenhouses, hotbeds, or cold frames frequently are transplanted or pricked out before they are set out. In some cases more than one transplanting is given prior to field setting.

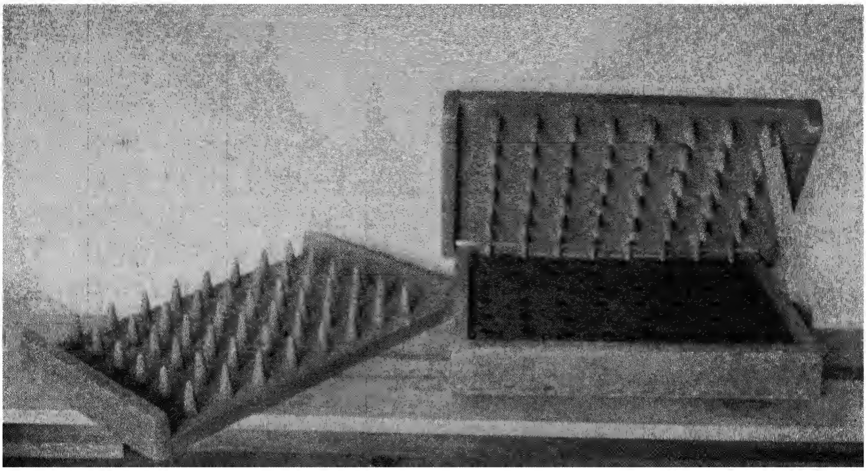

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FIG. 33 Spotting board used in spotting out seedling plants.

METHODS USED. A common practice is to sow the seed rather thickly and when the first true leaves are fairly well developed the seedlings are taken up and transplanted into flats or into the soil of the plant bed. For best results, the soil must be moist but not sticky. After the soil has been compacted with a board, holes to receive the plants are made with the finger, with a small dibble, or with a spotting board (Fig. 33). The use of the spotting board is desirable in order to save time and to have the plants evenly spaced in straight rows.

The spacing of the seedlings in the transplanting bed varies with the kind of plant and the time they are to remain in the bed. For celery, spacing varies from 1 by 1 inch to 2 by 2 inches, while larger-growing plants are spaced from 1½ by 1½ to 4 by 4 inches, depending on the time they are to be grown before setting in the field. Frequently plants, such as tomatoes, peppers, and eggplants, are transplanted more than once before field setting. At the first transplanting, they are spaced 1½ by 1½ or 2 by 2 inches, and, as soon as the plants begin to crowd, they are transplanted again, giving them more space. Unless saving of space is of importance, it is better to transplant only once and to give them the spacing desired at this time.

In transplanting, the soil should be pressed down around the roots, taking care to fill the hole at the bottom. Pressure should not be exerted against the stems of soft, succulent plants, as this might injure or kill them. After each transplanting, the soil should be watered to

settle it around the roots. Shading the plants for a day after transplanting usually is an advantage.

Clay pots, paper pots, peat pots, paper bands, wood veneer bands, and tin cans are frequently used for growing plants. Clay pots are considered best, but are expensive. Containers made of carbonaceous material, such as wood, paper, and raw peat, have given unsatisfactory results in some cases. These materials supply energy food for bacteria that cause the decomposition of the carbonaceous material. These bacteria consume nitrates and thus compete with the plants for the nitrate supply in the soil. The remedy is to supply sufficient nitrates for both the bacteria and the crop plants. The nitrates used by the bacteria are built up into complex compounds which, on the death and decomposition of the organisms, return the nitrogen to the soil. New clay pots absorb nitrates from the soil solution, and, for this reason, old pots often give better results than new pots. However, by soaking new pots in a solution of nitrate of soda the deficiency is made up. When individual containers are used for plant growing, the seed may be sown in the soil in the container or the seedlings may be grown in flats or beds and transplanted into the containers later. The main advantage in using pots and plant bands is that the roots are not disturbed when the plants are set in the field.

ADVANTAGES AND DISADVANTAGES OF TRANSPLANTING. The main advantages in transplanting plants prior to setting them in the field are (1) economy in the use of space in the greenhouse, hotbed, or cold frame; (2) saving of labor in the care of the plant bed; and (3) better spacing of the plants in the bed. When the plants are to be transplanted, much less space is needed for the seedbed than is the case when they are to remain in the seedbed until field setting. If they are not to be transplanted, sufficient space must be given to allow the plants to grow for several weeks without serious crowding. This would require more space than is needed for the first 2 or 3 weeks, and it also would require more labor in caring for the seedbed.

Transplanting usually results in a large increase in root branching with those plants that are commonly transplanted. This is an advantage when the plants are grown in beds and must be taken up for setting in the field. When the seedlings are removed from the seedbed, the ends of the roots are broken off and this results in greater root branching. Transplanted plants have a much greater number of short branch roots, therefore, a greater absorbing surface than do similar plants that have

not been transplanted. When these plants are taken up for setting in the field, there is a larger mass of feeding roots in the block of soil around the roots than in a similar block of soil around the roots of non-transplanted plants.

Many growers believe that transplanting results in the development of a more stocky plant with a better root system and that these increase the yield and hasten maturity. Experimental evidence presented by Loomis indicates that transplanting in itself does not increase yield or hasten maturity. The increase in space and better conditions usually given the transplanted plants do have this effect.

The main disadvantages of transplanting are the extra labor required and the check in growth that results from taking up and resetting the plants. The extra labor may be offset by the economy in the use of valuable greenhouse or hotbed space and in the saving of labor in caring for the plants. All plants are checked in growth by transplanting, but some are checked more than others. With those that are checked but little, this may be offset by the increase in root branching. Transplanting when the plants are large usually results in delayed maturity and, in some cases, in reduced yield. Sweet corn, cucumber, melon, and bean plants are seriously checked in growth by transplanting unless it is done while the plants are small. A second transplanting of these plants is very injurious.

DIFFERENCE IN RESPONSE TO TRANSPLANTING. Some plants are much more injured than others by transplanting, but Loomis has shown that any of the common vegetable plants can be transplanted satisfactorily during the early stages of growth. With corn, beans, and the cucurbits, there is only a short period when they are not seriously injured by transplanting. Loomis clearly established a correlation between the ability of the plant to withstand transplanting and the rate of new root development. Plants seriously injured by transplanting normally have a rapid rate of top growth and a slow rate of root growth, while those that are not greatly checked in growth by transplanting have a relatively slow rate of top growth and a rapid rate of root replacement. Root replacement seems to be the most important factor in transplanting. Figure 34 illustrates the difference in rate of root replacement of cabbage and corn plants. Eight days after transplanting the cabbage plant it had a much greater root area than the non-transplanted plant. With the corn plant, the non-transplanted plant had a much greater absorbing surface than the transplanted one. With most, if not all,

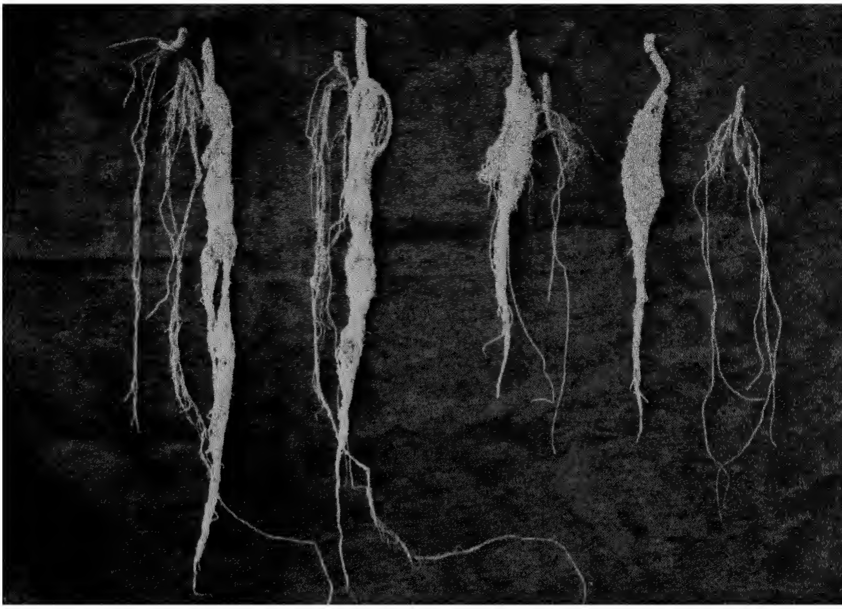

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FIG. 34. Root systems of cabbage plants (4 on left) and corn plants (4 on right) showing effect of transplanting on root branching. The plant on the left of each set of two is the nontransplanted plant and the one on the right is the transplanted one 8 days after transplanting.

vegetable plants, the rate of root replacement decreases as the age of the plant increases.

The recovery of the plant after transplanting is determined largely by its ability to obtain water. The roots are the most important factor involved in the recovery. The rate of new root formation depends on the kind of plant, the age of the plant, and on the quantity of stored food, especially carbohydrates. There is evidence that the roots of some plants are suberized or cutinized at an early age and such plants are slow to recover following transplanting. Deposition of suberin or cutin in the endodermis, or in the periderm layer, hinders water absorption and branch-root formation.

Hardening Plants

The term hardening is applied to any treatment that results in any firming or hardening of the tissues of plants. Hardening enables plants better to withstand unfavorable environmental conditions, such as low

temperatures, hot drying winds, certain types of insect injury, whipping in the wind, and injury from particles of soil and sand blown by the wind.

METHODS USED. Any treatment that results in a check in growth increases hardiness, but plants differ in the degree of resistance to certain conditions following the hardening treatment. For example, cabbage and other cool-season plants can be hardened to such extent that they will withstand temperatures several degrees below freezing and will survive actual ice formation in their tissues. Warm-season plants, such as the tomato, cucumber, melon, pepper, eggplant, and others, will not withstand ice formation, regardless of the degree of hardening. Checking growth of these results in only slight resistance to cold.

The usual methods of hardening plants are (1) exposing them to temperatures too low for good growth, (2) allowing the soil of the plant bed to become dry, and (3) a combination of these two. When plants are grown under protection during cool weather, it is easy to subject them to relatively low temperatures by reducing the heat, in the case of greenhouse or hotbed, and by ventilation at the proper time. If the plants are grown during warm weather, it is not possible to harden by low temperature, hence some other method must be used. Withholding water is the best method in this case, but when the plants are grown in outdoor beds, the success of this method is dependent on the weather. During a period of rainy weather, hardening cannot be accomplished in this manner, but by lifting the plants slightly with a fork or by cutting the roots on both sides of the rows of plants, hardening can be accomplished. In both cases, the water-absorbing surface of the root system is reduced and, if the treatment is severe enough, growth is checked and hardening results.

Hardening should be gradual. It is better to maintain a moderate rate of growth throughout the plant-growing period than to have rapid growth up to the last week or two and then to check growth suddenly. Overhardening results in delayed growth when the plants are set out. Crist showed that severe hardening of tomato plants decreased the early yield of fruit in the greenhouse. It seems probable that overhardening would delay fruiting in the field also and might reduce the total yield.

CHANGES DURING HARDENING. Rosa showed that hardening is accompanied by (1) slowing up of the rate of growth; (2) thickening of the cuticle; (3) increasing the waxy covering on the leaves of

certain kinds of plants; (4) development of a pink color, especially in the stems, petioles, and veins; (5) increasing the dry matter; (6) increasing the content of water-holding colloids; and (7) decreasing the percentage of freezable water and other internal changes. Usually the leaves of hardened plants are of a deeper green color and smaller in size than those of tender plants of the same kind.

Hardened plants develop new roots faster than do tender ones and this is of special importance in plants that are grown in beds and later set in the field. The accumulation of food materials during the hardening treatment is important in new root formation. Hardening also increases the water-retaining power of the cells and this is of importance in resistance to water loss incident to freezing and in transpiration. Harvey suggests that in the hardening of cabbage plants there is a change in the constituents of protoplasm which prevents their precipitation as a result of the physical changes incident to freezing. The proteins are changed to forms which are less easily precipitated.

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8

PLANTING IN THE OPEN

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There are more than 40 vegetables which can be grown in the field, directly from seed, in the middle South without the use of heat, and this number is increased to 50 for South Texas and Florida. There are about a dozen others that should be grown in flats, boxes, or beds and later transplanted. Whenever it is possible to do so, vegetables should be grown in the open with no artifical conditions, as they are more hardy, stocky, and better able to withstand varying outdoor conditions. For the sake of earliness, those who grow vegetables for the market in the middle South must depend on artificial conditions to get many plants started early in the spring. In the vegetable-growing sections of Florida and Gulf sections of other states, some vegetables are planted in the late fall and grown as winter crops.

Planting Seed

SPACING THE ROWS. For open field conditions 3½ feet is the standard width between rows for more than half of the common vegetables, such as beans, pepper, eggplant, cabbage, corn, and potatoes. This permits 60 rows to the square acre. Rows of this width allow ample room for the use of horse-drawn equipment in cultivating, spraying, or harvesting, as well as providing space for top and root development of plants. When space is limited and hand labor is used, the width may be reduced to 3 feet or less (Fig. 35).

Vegetables which have a narrow, spreading root system and small top, such as onions, lettuce, carrots, beets, radishes, and celery, will have ample room in 2½-foot rows. These vegetables are usually intensely grown and it is necessary for economic reasons to produce a heavy yield from the land. Most of these will stand crowding and are not seriously injured by partial shade.

Plants with large leaves, trailing vines, or with fruit which require direct sunlight for proper development must have more room. Among these are melons, squash, pumpkins, and cucumbers, which should be

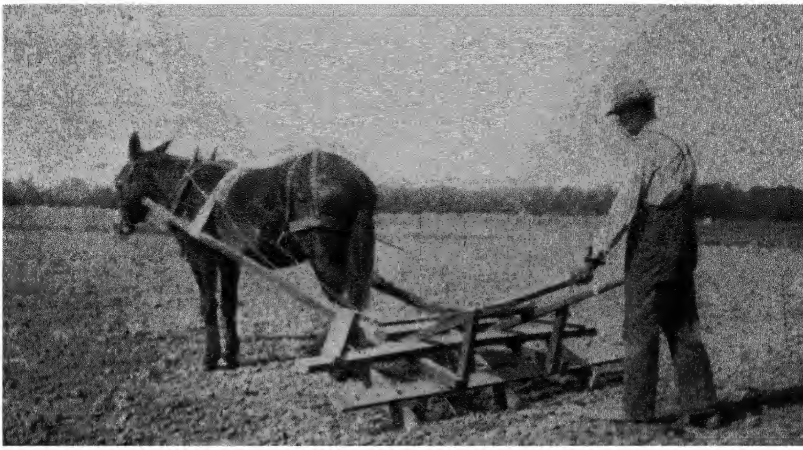

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FIG 35 An adjustable homemade row marker is convenient for spacing rows.

planted in rows 4 to 12 feet apart, depending on the kind of crop, and local practice.

PREPARING THE SEED BED. In preparing the soil for planting, first remove anything that will interfere with plowing, spading, or hoeing the soil. If the soil contains sod or clay, it should be plowed to a depth of 6 inches at least a month before planting. Special care should be taken to remove from the land any portions of diseased plants which might serve as a source of infection to the new plants.

About 2 weeks before planting, the soil should be replowed, harrowed, rolled, and dragged until it is smooth and mellow. It is then ready to be laid off in rows properly spaced to accommodate the vegetables to be grown. Preparation of beds will vary for seed of different kinds, specific directions for this being found in the special crop chapters.

PLANTING METHODS. Vegetable seed are planted as follows: (1) By hand in hills, rows, or broadcast (Table 10); (2) with one-row hand seeders; (3) with one-, two-, or three-row, horse-drawn seeders; and (4) with six- to ten-row, tractor-drawn seeders. The method of seeding depends largely on the quantity of seed to be planted and the rapidity with which the work must be done. Regardless of the method of planting, one should make sure that the seeds are planted at the proper depth and that the soil is left smooth and compact.

Table 10. Approximate Chart for Planting Vegetables in the Open Through the Middle South [1]

Vegetables	How Usually Planted	Approximate Number of Seed per Ounce [2]	Seed for 100 Feet of Row	Seed or Plants per Acre	Distance between Rows in Feet	Row Space in Inches	Depth to Plant in Inches [1]
Asparagus, seed	Drills	1,400–1,600	1 oz.	4–5 lbs.	1–2	3–6	1
Asparagus, roots	In beds	—	40–60 rts.	4–8,000 rts.	4–6	18–24	6–12
Bean, bush lima	Drills	20–90	1–2 lbs.	40–60 lbs.	2–3	3	1
Bean, pole lima	Drills	20–60	1 lb.	30–40 lbs.	3–4	8	1
Bean, bush snap	Drills	55–110	1–2 lbs.	50–80 lbs.	3	3	1
Bean, pole snap	Drills	45–90	1 lb.	30 lbs.	3–4	6–8	1
Beet	Drills	1,500–2,200	1 oz.	10–12 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	2–4	$\frac{3}{4}$
Broccoli	Transplanted	9,000–12,000	$\frac{1}{4}$ oz.	$\frac{1}{4}$ lb.	3	24	$\frac{1}{2}$
Brussels sprouts	Transplanted	9,000–12,000	$\frac{1}{4}$ oz.	$\frac{1}{4}$ lb.	3	24	$\frac{1}{2}$
Cabbage, seed	Transplanted	9,000–12,000	$\frac{1}{4}$ oz.	$\frac{1}{4}$ lb.	3	14–24	$\frac{1}{2}$
Cabbage, plants	In rows	—	60–100 pls.	10,000 pls.	3	14–24	3
Cantaloupe	In hills	940–1,060	$\frac{1}{2}$ oz.	2 lbs.	5–7	2–4	1
Carrot	Drills	16,000–22,000	$\frac{1}{2}$ oz.	3–5 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	1–3	$\frac{1}{2}$
Cauliflower	Transplanted	9,000–12,000	$\frac{1}{4}$ oz.	$\frac{1}{4}$–$\frac{1}{2}$ lb.	2–3	18–24	$\frac{1}{2}$
Celery	Transplanted	30,000–60,000	$\frac{1}{8}$–$\frac{1}{4}$ oz.	$\frac{1}{4}$–$\frac{1}{2}$ lb.	2–4	4–8	$\frac{1}{4}$–$\frac{1}{2}$
Collard, plants	In rows	8,000–12,000	95–100 pls.	10,000 pls.	3	12–18	3
Collard, seed	Transplanted	—	$\frac{1}{4}$ oz.	$\frac{1}{4}$–$\frac{1}{2}$ lb.	3	12–18	$\frac{1}{2}$
Corn, sweet	Drills	105–350	3–4 oz.	12–15 lbs.	3–4	12–30	1–2
Cucumber	In hills	1,100–1,200	$\frac{1}{2}$ oz.	2 lbs.	4–6	24–48	1
Eggplant, plants	In rows	6,000–8,000	50–70 pls.	4–8,000 pls.	3–5	18–30	3
Horseradish, roots	In rows	—	100 pls.	15,000 pls.	2–3	12–18	4
Irish potato	In rows	—	6–8 lbs.	8–15 bu.	$2\frac{1}{2}$–$3\frac{1}{2}$	12–18	2–4
Kale	Transplanted	9,000–12,000	$\frac{1}{2}$ oz.	3–5 lbs.	2	12–24	$\frac{1}{2}$
Kohl-rabi	Transplanted	9,000–12,000	$\frac{1}{3}$ oz.	3–4 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	4–6	$\frac{1}{2}$
Lettuce	Transplanted	20,000–30,000	$\frac{1}{2}$ oz.	3–4 lbs.	$1\frac{1}{2}$–3	4–12	$\frac{1}{4}$–$\frac{1}{2}$
Mustard	Drills	13,000–16,000	$\frac{1}{2}$ oz.	4–5 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	4–8	$\frac{1}{4}$–$\frac{1}{2}$
Okra	Drills	500–600	2 oz.	10 lbs.	3–4	12–24	1
Onion, seed	Drills	7,000–8,000	$\frac{1}{2}$–1 oz.	3–5 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	2–4	$\frac{1}{2}$

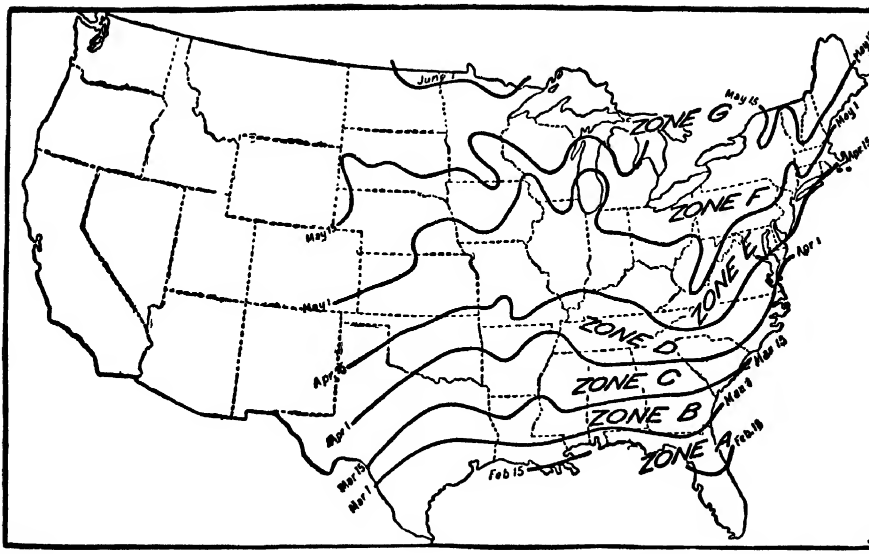
TABLE 10 — *Continued*

Onion, plants	In rows	—	200–300 pls.	40–60,000 pls.	2–3	3–4	2
Onion, sets	In rows	—	1–2 lbs.	12–20 bu.	1–3	3–4	$1\frac{1}{2}$
Parsley	Drills	14,000–16,000	$\frac{1}{4}$ oz.	3 lbs.	1–2	3–8	$\frac{1}{4}$–$\frac{1}{2}$
Parsnip	Drills	10,000–14,000	$\frac{1}{3}$ oz.	3–5 lbs.	1–2	3–6	$\frac{3}{4}$
Pea, English	Drills	85–210	1–2 lbs.	80–120 lbs.	2–3	1–3	1–$1\frac{1}{2}$
Pea, cow or field	Drills	—	1 lb.	30–60 lbs.	3	2	2
Pepper, plants	In rows	3,500–7,500	60–80 pls.	14,500 pls.	2–4	16–24	3–4
Pumpkin	In hills	145–200	1 oz.	2–4 lbs.	8–12	36–96	1
Radish	Drills or broadcast	3,000–4,000	1–2 oz.	8–15 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	1–2	$\frac{1}{2}$
Rhubarb (Pie plant)	Bed, row	1,400–1,500	35–50 rts.	3–5,000 rts.	4–6	24–36	Tips out
Rutabaga	Drills	10,000–17,000	1 oz.	2–4 lbs.	2	4–6	$\frac{1}{2}$
Spinach	Drills	1,975–2,500	1 oz.	8–15 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	2–5	$\frac{1}{2}$–1
Spinach, New Zealand	Drills	280–340	1 oz.	8–10 lbs.	$1\frac{1}{2}$–$2\frac{1}{2}$	3	1
Squash, Summer	In hills	200–400	1 oz.	3–4 lbs.	3–4	20–40	1
Sweet potato, plants	In rows	—	60–90 pls.	6–12,000 pls.	3–4	14–22	3–4
Tomato, seed	Transplanted	7,000–20,000	$\frac{1}{3}$ oz.	$\frac{1}{4}$ lb.	3–6	2–4	$\frac{1}{4}$–$\frac{1}{2}$
Tomato, plants	In rows	—	40–80 pls.	6,000 pls.	3–6	18–48	3–4
Turnip	Drills	12,000–17,000	$\frac{1}{2}$ oz.	2–4 lbs.	1–3	2–4	$\frac{1}{4}$–$\frac{1}{2}$
Turnip greens	Broadcast	—	1 oz	4–6 lbs.	Broadcast	Broadcast	$\frac{1}{4}$–$\frac{1}{2}$
Watermelon	In hills	200–325	1 oz.	1–3 lbs.	8–12	72–144	1

[1] The information contained in this chart is only approximate. Credit is due the H. G. Hastings Seed Co., Reuter Seed Co., Ferry-Morse Seed Co., Associated Seed Growers, Inc., Nicholson Seed Co., Steckler Seed Co., and Russell-Heckle Seed Co., for supplying information in the preparation of this chart.

[2] Varies with variety and sample. Prepared by Gordon Morrison, Ferry-Morse Seed Co.

[3] Deeper as season advances. Depends on soil type also.



U. S. Dept. Agr Farmers' Bull. 934.

FIG. 36. A zone map of the United States, based on the average dates of the latest killing frost in spring. By referring to Table 11, the earliest safe date of planting vegetables in the open in the various zones may be determined.

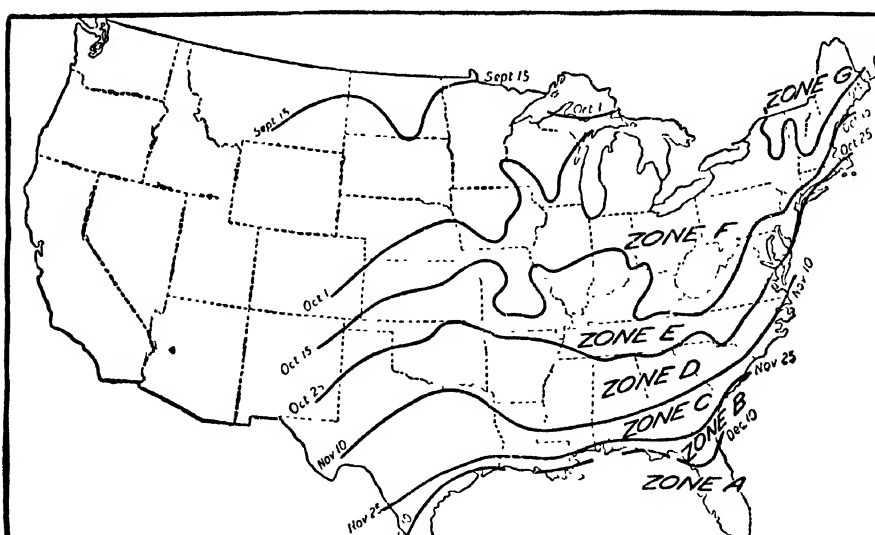


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FIG. 37. Zone map of the central and eastern part of the United States based on average date of first killing frost in autumn. By referring to Table 12, the latest safe date for planting vegetables for the fall garden in various zones may be determined.

Melon, squash, and cucumber seed may be planted by hand or with drills of various kinds. They may be planted in hills or in continuous rows. On level land, the hills may be checked in order that cultivation can be carried on in both directions. After the land is prepared and laid off, a garden hoe is the only tool that is necessary. In some cases, corn or tomatoes may be checked also. Most winter-grown salad greens, including mustard, turnips, rape, tender greens, and spinach, may be sown by hand and covered with a garden rake. These very small seed are sown to advantage if mixed with four or five parts of fine soil.

Seeders vary from a simple bean dropper to complicated machines which have several attachments for manipulating the soil, fertilizer, and seed in the process of planting. One well-known horse-drawn planter performs the following operations simultaneously: (1) Opens two furrows for placement of fertilizer, (2) deposits any desired quantity of fertilizer, (3) covers the fertilizer in the furrow, (4) makes up seed bed, (5) levels off bed at desired height, (6) opens the furrows for seed, (7) sows any quantity of seed, (8) covers the seed to the proper depth, and (9) packs the soil over them.

Standard grain drills with a fertilizer attachment may be adjusted to plant different kinds of seed. When planting is done on a large scale, two or three grain drills may be pulled by a tractor, planting 20 acres or more in one day.

Fresh seed of most kinds should be used, and even then, a germination test is advisable. Soaking certain slow-germinating seeds, such as beets, okra, celery, and pepper, in water over night, just prior to planting, increases the percentage and rapidity of germination. Seeds that have been soaked are more difficult to sow with a seed drill than those that have not been soaked.

PLANTING DATES. The time of planting vegetable seed is based on locality, hardiness, length of season, and time of maturity. The earliest dates of planting winter crops is October or November in the extreme South. Following the advance of the season northward, this date may approximate June 15 in the extreme northern portion of the country. The grower should know the dates of the last killing frost in the spring (Fig. 36) and the first killing frost in the fall (Fig. 37) for his particular locality, and use these dates as the basis for planting crops that are sensitive to frost. Local experience is usually a safeguard. Table 61 shows the approximate dates on which a large number of vegetables can be safely planted in the region through middle South Carolina,

Georgia, and Alabama. There is a difference in these dates of at least 10 days from year to year, as well as variations due to altitude, bodies of water, swamps, and large tracts of timber. Figure 36 and Table 11

TABLE 11. EARLIEST SAFE DATES FOR PLANTING IN THE OPEN IN THE ZONES OF THE UNITED STATES ILLUSTRATED IN FIGURE 36

CROP	ZONE A	ZONE B	ZONE C	ZONE D	ZONE E
Asparagus	(Not grown)	Feb. 15 to Mar 1	Mar. 1 to 15	Mar. 15 to Apr 15	Apr. 15 to May 1
Artichoke:					
Globe	Mar. 1 to Mar 15	Mar. 15 to Apr 1	Apr. 1 to 15	Apr. 15 to May 15	May 1 to 30
Jerusalem	Feb. 1 to 15	Feb. 15 to May 1	Mar. 1 to 15	Mar. 15 to Apr. 1	Apr. 1 to 15
Bean:					
Lima	Mar 1 to 15	Mar. 15 to Apr 1	Apr. 1 to 15	May 1 to 15	May 15 to June 1
Snap	Feb 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to 30	Apr 1 to May 1	May 1 to 15
Beet	Feb 1 to 15	Feb. 15 to Mar. 1	Mar 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Brussels sprouts	Feb. 1 to 15	Feb. 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr 15 to May 1
Cabbage	Jan 1 to Feb 1	Jan. 15 to Feb. 15	Feb. 15 to Mar 1	Mar. 1 to 15	Mar. 15 to Apr. 15
Carrot	Feb. 1 to 15	Feb 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Cauliflower	Feb. 1 to 15	Feb. 15 to Mar 1	Mar 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Celery	Feb. 1 to 15	Feb. 15 to Mar 1	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Chard	Feb 1 to 15	Feb. 15 to Mar 1	Mar 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Collard	Jan. 1 to Feb 1	Feb. 1 to 15	Feb. 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15
Corn, sweet	Feb. 15 to Mar 1	Mar. 1 to 15	Mar. 15 to Apr 1	Apr 1 to May 1	Apr. 15 to May 15
Cucumber	Mar. 1 to 15	Mar. 15 to Apr 1	Apr 1 to 15	Apr 15 to May 1	May 1 to June 1
Eggplant	Mar. 1 to 15	Mar 15 to Apr 1	Apr 1 to 15	Apr 15 to May 1	May 1 to June 1
Garlic	Jan. 1 to Feb 1	Feb. 1 to 15	Feb. 15 to Mar 1	Mar. 1 to 15	Mar. 15 to Apr. 15
Kale	Jan 1 to Feb. 1	Feb 1 to 15	Feb. 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15
Kohl-rabi	Feb. 1 to 15	Feb. 15 to Mar 1	Mar. 1 to 15	Mar. 15 to Apr. 1	Apr. 1 to May 1
Lettuce:					
Head	Feb. 1 to 15	Feb 15 to Mar 1	Mar. 1 to 15	Mar 15 to Apr 15	Apr. 1 to May 1
Leaf	Jan. 1 to Feb 1	Feb. 1 to 15	Feb. 15 to Mar 1	Mar 1 to 15	Mar. 15 to Apr. 15
Melon	Mar. 1 to 15	Mar. 15 to Apr 1	Apr. 1 to 15	Apr 15 to May 1	May 1 to June 1
Mustard	Feb. 1 to 15	Feb. 15 to Mar 1	Mar. 1 to 15	Mar 15 to Apr. 1	Apr. 1 to May 1
Okra, or gumbo	Feb. 15 to Mar. 1	Mar. 15 to Apr 1	Mar. 15 to 30	Apr 15 to May 1	May 1 to 15
Onion:					
Seed	Feb. 1 to 15	Feb. 15 to Mar 1	Mar 1 to 15	Mar 15 to Apr 1	Apr. 1 to May 1
Sets	Jan. 1 to Feb 1	Feb. 1 to 15	Feb 15 to Mar 1	Mar 1 to 15	Mar. 15 to Apr. 15
Parsley	Feb 1 to 15	Feb 15 to Mar 1	Mar 1 to 15	Mar 15 to Apr 1	Apr 1 to May 1
Parsnip	Feb. 1 to 15	Feb 15 to Mar. 1	Mar 1 to 15	Mar. 15 to Apr. 1	Apr. 1 to May 1
Pea:					
Smooth	Jan 1 to Feb 1	Feb 1 to 15	Feb. 15 to Mar 1	Mar 1 to 15	Mar 15 to Apr. 15
Wrinkled	Feb 1 to 15	Feb. 15 to Mar 1	Mar 1 to 15	Mar. 15 to Apr 1	Apr 1 to May 1
Pepper	Mar 1 to 15	Mar. 15 to Apr 1	Apr 1 to 15	Apr 15 to May 1	May 1 to June 1
Potato:					
Irish	Jan 1 to Feb. 1	Feb. 1 to 15	Feb. 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15
Sweet	Mar 1 to 15	Mar 15 to Apr. 1	Apr 1 to 15	Apr 15 to May 1	May 1 to June 1
Pumpkin	Mar. 1 to 15	Mar 15 to Apr 1	Apr. 1 to 15	Apr 15 to May 1	May 1 to June 1
Radish	Jan 1 to Feb 1	Feb 1 to 15	Feb 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15
Rhubarb	(Not grown)	(Not grown)	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Salsify	Feb. 1 to 15	Feb 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr 15	Apr. 15 to May 1
Spinach	Feb 1 to 15	Feb. 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15	Apr. 15 to May 1
Squash	Mar. 1 to 15	Mar. 15 to Apr 1	Apr. 1 to 15	Apr. 15 to May 1	May 1 to June 1
Tomato	Mar. 1 to 15	Mar. 15 to Apr. 1	Apr. 1 to 15	Apr. 15 to May 1	May 1 to June 1
Turnip	Jan 1 to Feb 1	Feb. 1 to 15	Feb. 15 to Mar. 1	Mar. 1 to 15	Mar. 15 to Apr. 15

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show the earliest safe date for planting vegetables in the spring; while Figure 37 and Table 12 give the latest safe dates for fall planting. Table D in the APPENDIX also gives average growing seasons, frost dates, rainfall, and temperatures for southern localities.

TABLE 12. LATEST SAFE DATES FOR PLANTING VEGETABLES FOR THE FALL GARDEN IN THE ZONES OF THE UNITED STATES ILLUSTRATED IN FIGURE 37

Crop	Zone B	Zone C	Zone D	Zone E
Bean, snap	Oct. 1 to 15	Sept. 15 to 30	Aug. 15 to 30	Aug. 1 to 30
Beet	Oct. 1 to 15	Sept. 15 to 30	Aug. 1 to 30	July 15 to Aug. 15
Cabbage		Sept. 1 to 15	Aug. 15 to Sept 1	July 15 to Aug. 15
Carrot		Sept. 1 to 15	Aug. 15 to Sept 1	July 15 to Aug 15
Cauliflower		Sept. 1 to 15	Aug. 1 to Sept 1	July 1 to Aug. 1
Celery		Oct. 1 to 15	Sept. 1 to 30	July 1 to Aug 1
Corn, sweet		Aug. 15 to 30	Aug. 1 to 15	July 15 to Aug. 15
Cucumber		Aug. 15 to 30	Aug. 1 to 15	July 15 to Aug. 15
Kale		Oct. 15 to Nov. 15	Oct. 1 to 30	Sept. 1 to 30
Lettuce		Oct. 15 to Nov. 15	Oct. 1 to 15	Sept. 1 to 30
Mustard		Oct. 15 to Nov. 15	Oct. 1 to 15	Sept. 1 to 30
Parsley		Oct. 15 to Nov. 15	Oct. 1 to 15	Sept. 1 to 30
Pea		Oct. 15 to Nov. 15	Oct. 1 to 15	Aug. 15 to Sept. 15
Potato:				
Irish		Aug. 15 to 30	Aug. 1 to 15	July 1 to 30
Sweet	Aug. 15	Aug. 1 to 15	July 15 to 30	June 1 to 30
Radish		Oct 15 to 30	Oct. 1 to 15	Aug. 15 to Sept. 30
Spinach		Oct. 15 to 30	Oct 1 to 15	Aug. 15 to Sept. 30
Tomato		Aug. 15 to 30	July 15 to Aug. 15	July 1 to 30
Turnip		Oct. 15 to 30	Oct. 1 to 15	Aug 15 to Sept. 30

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Hardy vegetables, including beets, cabbage, carrots, collards, mustard, onions, peas, rape, shallots, spinach, and turnips, may be planted in the fall or winter because they are not easily injured by freezing. Semi-hardy vegetables, such as lettuce and radish, must be planted in ice-free seasons, though they will stand frosts. Tender vegetables cannot be safely planted until all danger of frost is past and the ground becomes warm, as is shown in Tables 4 and 61.

The length of season before maturity influences the time of planting different crops. Such vegetables as eggplants, peppers, and sweet potatoes are planted only once each year and continue to grow throughout the season, while other vegetables such as snap beans, radishes, carrots, lettuce, and tomatoes may be planted at intervals during a period of approximately 5 months. Tender vegetables which require 100 days or more to reach maturity must be planted in the spring, and as a rule, the earlier after the soil becomes warm, the better.

Vegetable seed for planting should be treated for the control of bacterial and fungous diseases. These organisms are carried either within the seed tissue or on the surface of the seed. The ideal treatment sterilizes the seed without injuring germination or retarding subsequent growth, and, if the seed is not recontaminated, decay after planting will be prevented and damping-off of seedlings will be greatly reduced.

TREATING SEED. Three types of seed treatment in common use are as follows: (1) The hot-water method is used to control disease organisms that reside within seed tissue. Treatment generally consists of immersing the seed in water heated to 120° to 125° F. for approximately 10 minutes, immediately before planting. (Some hard seeds germinate more readily after this treatment.) (2) Liquid chemical treatments for the control of disease organisms may be given immediately after harvest or just before planting. If given just after harvest, the seed should be dried, packaged, and stored in such a manner as to avoid recontamination. Chemicals and methods of treatment are discussed in Chapter 11. (3) Chemical dust treatments are similar to the above, with the exception that the material is applied in the form of a dust rather than in solution. Chemical treatments may be given at any time before planting, and a residue of the chemical should remain on the seed.

The particular type of seed treatment to use depends on the disease or diseases involved and the susceptibility of the seed to injury. It has been found advisable to treat some seeds, such as pepper and tomato, as they are removed from the fruit, and before the seed are dry. Information regarding seed treatment should be obtained from some reliable source, and should be followed carefully. Most commercial compounds carry directions in detail on the packages. In some states there are laws requiring and regulating treatment of vegetable seed. In so far as possible, one should purchase only planting seed that have been properly treated for the control of seed-borne diseases.

PLANTING DEPTHS. The depth of planting seed depends on a number of conditions, chief among which are texture of soil, availability of moisture, and the length of time required for germination (Table 10). When conditions are ideal, seed will germinate best when planted at a depth of about four times that of the diameter of the seed.

A sandy soil, which dries out readily and does not form a crust after each rain, requires that seed be planted about twice as deeply as a soil with clay surface. In times of drought, seed should be planted at about twice the depth as when the surface soil is moist. Seed which germinate slowly, such as okra, pepper, beets, and carrots, should be planted more deeply than those which germinate readily, such as cabbage, tomato, turnip, and mustard.

Regardless of the depth of planting or kind of seed, the surface of the soil should be leveled and firmly pressed above the seed in such a manner

that rain water will neither wash down the bed nor puddle above the seed. While opening a furrow with a hoe and dropping and covering the seed by hand usually gives satisfactory results, a mechanical seeder is desirable because it is more economical of seed and covers it more uniformly.

PLANTING RATES. Quality of seed is the chief factor that determines rate of seeding. With most vegetables, seed is the cheapest of the five important items which constitute cost of production, namely, land, labor, fertilizer, equipment, and seed. The other items are almost the same with a poor stand of plants as with a full stand. It is thus poor economy to limit the quality or quantity of seed that goes into the production of a crop of vegetables.

Table 10 shows the rate of seeding of most vegetables which are grown in the South, but this is subject to wide variation, based largely on whether the seed is sown in drills, hills, or broadcast. A certain rate of seeding is used when seed is plentiful and space is limited, and a much smaller amount of seed is used when seed is scarce and land is plentiful. Time may be the limiting factor and the gardener may use twice the normal amount of seed to make sure there will be no replanting or second planting. Unfavorable weather conditions may make it necessary to increase greatly the quantity of seed. Fully three times as much seed is required to broadcast an area as to plant it in rows.

ATTENDING AFTER EMERGENCE. When properly treated seed is planted in clean soil, the young plants upon emergence will be without diseases and insects. Precautions should be taken to keep them free of pests by spraying at an early date. Colorado potato beetles attack potato and tomato plants as soon as they are well out of the ground, and Mexican bean beetles begin eating bean plants as soon as the fourth leaf is formed. Leaf-spot and other diseases become active at the same time.

If rain occurs between the time of planting and emergence of the seedlings, a crop of weeds and grass should be destroyed immediately by cultivation, hoeing, or hand pulling. If practiced, irrigation should begin after the rows and middles are weeded. An application of quick-acting fertilizer is also advantageous during the first 10 days to insure early rapid growth of the young plants.

Setting Plants

By following plant-growing directions given in Chapter 7, plants of broccoli, Brussels sprouts, cabbage, cauliflower, celery, collard, eggplant,

lettuce, onion, pepper, sweet potato, and tomato will be ready to set in the field at the proper time.

PREPARING THE PLANT BED. The initial steps in preparing a plant bed are similar to those for a seed bed. Beds for setting long-rooted plants as tomatoes, sweet potatoes, and peppers should be higher (or opened deeper) than beds for short plants such as lettuce. Rows for setting onions or lettuce should be about 2 feet apart, while 3 or $3\frac{1}{2}$ feet is required for the other vegetables to be transplanted.

SETTING DISTANCES. The distance between plants in the row varies with the scarcity of land, fertility of land, and kind of vegetables. Onion, lettuce, and celery plants require less than one foot, while the tomatoes can utilize 2 or 3 feet to advantage.

The total yield per acre of most vegetables is increased by close planting, to a point where the tops receive insufficient sunlight; however, the size of the individual plants or fruits is usually smaller. Greater yields of pepper in Georgia were obtained when the plants were set 12 inches apart as compared with plantings of 18, 24, 30, or 36 inches, but the percentage of large specimens was reduced by crowding. In the case of sweet potatoes, the jumbos can be practically eliminated by setting plants 16 inches or less apart rather than 24 inches or more.

With the exception of sweet potatoes, plants should be set close enough together so that the mature specimens will touch without crowding.

SETTING METHODS. There are three general methods of setting plants: (1) Hand setting, where holes are dug with a hoe or dibble. The plants are dropped into the holes, $\frac{1}{2}$ to one pint of water is applied, and the plant is set and packed, making four distinct hand operations. This is the best method of setting plants because each one can be given individual attention. After the water has soaked well into the soil, the surface around the plant should be covered with dry soil. (2) Hand-machine setting, where holes are made with the point of the plant setter and plants are placed therein from the machine. A quantity of water is poured by pressing a lever with the thumb, and the plant roots are covered with dry soil, all in one operation. This method is little used because hand setters are slow and difficult to operate. (3) Riding-machine setting, where a two-horse machine opens a furrow into which a riding boy drops a plant. Water is immediately released from a barrel, and two curved slides cover the plant roots by raking soil from either side. This is a rapid method of setting plants and is quite

satisfactory when the soil is well prepared and not too dry. With such a machine, one careful driver and two boys to place the plants may plant as much as 10 acres a day.

Plants do best when set on a cloudy day, late in the afternoon, just after a rain, or just before a rain. Plants having root systems which are largely lost in transplanting are more seriously injured than plants moved with the roots intact; also, young plants whose tissues have not begun to suberize appreciably are less injured by transplanting than older plants.

Tomato, cabbage, eggplant, and pepper plants are sometimes checked to permit cultivation in both directions.

SIZE AND QUALITY OF PLANTS. With the exception of lettuce and celery, most plants to be set in the field should be about 6 inches long, equally divided between top and root, and from 8 to 12 weeks old. Larger and older plants are often used to advantage, but those more than 8 inches long are difficult to transplant and the mortality is higher.

Freedom from disease, freshness, vigor, and trueness to variety and type are more important than size. In so far as possible, plants should be set in the field on the same day they are pulled from the beds, discarding all that show abnormalities. During the interval that they are out of the ground the roots should be kept moist and the tops relatively dry and in the shade. The roots of plants held over night should be wrapped in wet sphagnum moss.

SETTING DATES. Tomato, eggplant, pepper, and sweet potato plants grow only during the warm season and should be set in the field only when the soil is warm. Successive crops of tomatoes may be planted in regions where favorable conditions continue for some months.

Lettuce, onions, cabbage, and related plants are semihardy and live through the winter in the lower South. In the Appalachian region they are grown as spring or fall crops, not being able to stand either the extreme heat of summer or cold of winter.

The exact time to set plants depends on (1) the condition of the plants, (2) the condition of the soil, and (3) prevailing weather. Often it is profitable to postpone planting until a time when conditions are suitable. Only when plants are plentiful and the season is well advanced is it advisable to plant on poorly prepared land or under adverse weather conditions.

SETTING RATES AND DEPTHS. Plants should be set in the field in about the same manner as they grew in the cold frame, but with

more room and from $\frac{1}{2}$ to 1 inch deeper. Setting should be shallow enough to expose fully the bud and deep enough to prevent the plant from falling over and exposing the stem to the sun. The amount of stem left above ground in setting tomato, pepper, cabbage, eggplant, and sweet potato plants should be about 4 inches, even if the below-ground portion is much more than this.

ATTENDING AFTER SETTING. When setting only a few plants, it is possible to give them protection from the mid-day sun by setting a shingle on the south side of each plant. Paper or cardboard protectors are also used to shield newly set plants from drying winds and sun. Only in rare instances is it necessary to water most plants other than at the time of setting, except in arid or semiarid regions. Certain intensely cultivated vegetables such as onions, lettuce, and celery are sometimes grown under irrigation even in humid regions, in which case watering should be started immediately after the plants are set. Mulching the soil with fine straw, decayed manure, or treated paper is sometimes practiced with summer vegetables such as tomatoes, pepper, and celery. The soil should be thoroughly cultivated just prior to mulching. Chapter 10, on IRRIGATING AND MULCHING, gives full information on these practices. If a rapid growth is desired early in the spring, as with lettuce, cabbage, celery, and others, a side dressing of readily soluble nitrogenous fertilizer is recommended.

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9

CULTIVATING AND ROTATING

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Cultivating

Cultivation or intertillage of crops is a very old agricultural practice and its benefits are well recognized. The main benefits derived from cultivation are: (1) Weed control which aids in conserving moisture and nutrients; (2) conserving moisture through the formation and maintenance of a soil mulch; and (3) increasing aeration of the soil, thereby favoring nitrification and other chemical changes in the soil.

The principles of cultivation apply generally. Limited experimental cultivation work has been done with vegetables in the South, but valuable tests have been conducted in other sections of the country. Special cultivation practices employed in producing different vegetables are discussed in the special crop chapters in Section II; so this chapter deals primarily with basic principles.

EFFECT OF CULTIVATION ON YIELD. Under most conditions, cultivation increases the yield of crop plants. This increase in yield results mainly from weed control, but the formation and maintenance of a soil mulch may be an important factor under some conditions. Data reported by Thompson from experiments carried on at Ithaca, New York, on a sandy loam soil show clearly that weed control is of major importance. They show also that the maintenance of a soil mulch was of value to all crops under some conditions and of no benefit under other conditions. Similar results were reported by Thompson, Wessels, and Mills from experiments carried on at Riverhead, New York, on a sassafras loam soil. In the experiments at Riverhead, cultivation once a week throughout the season was compared with cultivation once a week until the crops were about half grown, and with scraping the surface of the soil to control weeds. In one set of plots, the weeds were allowed to grow in order to determine their effect on the yield of the various crops. By comparing the yields of the cultivated and scraped plots, the value of the soil mulch is shown, since weeds were

eliminated as a factor in the two treatments. A summary of the results of experiments at Riverhead is given in Table 13.

TABLE 13. EFFECT OF CULTIVATION ON YIELD

Kind of Crop	Average Yield of Marketable Portion of Crop in Pounds per Plot			
	Cultivated all season	Cultivated half of season	Scraped	Weeds allowed to grow
Carrot	505.3	506.4	519.5	27.9
Beet	240.3	239.7	233.2	45.6
Cabbage	233.6	234.6	207.5	129.1
Onion	67.7	69.6	64.3	3.6
Tomato	164.0	166.6	166.8	23.3
Potato	148.3	150.4	158.8	52.7

A study of the data in Table 13 will show only slight difference in yield between the two sets of cultivated plots and between these and the scraped plots. In no case are the differences in average yields between the two sets of cultivated plots significant. The cultivated plots of cabbage produced a higher average yield than did the scraped plots, but the difference is not statistically significant. The scraped plots of potatoes consistently produced a slightly larger yield than the cultivated plots and the difference is statistically significant. Results somewhat similar to these were reported by Merkle and Irvin in Pennsylvania with corn, beans, potatoes, mangels, and cabbage.

EFFECTS OF CULTIVATION ON SOIL MOISTURE. Cultivation nearly always results in moisture conservation through the destruction of weeds. The formation of a soil mulch may result in conserving moisture by preventing surface run-off and by slowing up the movement of water to the surface where it evaporates. However, the benefits derived from the soil mulch have been greatly overemphasized. Results of many experiments have shown much less conservation of moisture than is commonly believed. In a series of studies by Thompson in New York covering a period of five years, it was shown that cultivation, as compared with scraping the soil to control weeds, resulted in moisture conservation in about two-thirds of the comparisons, but in these, the differences were slight in most cases. In the other comparisons, cultivation resulted in actual loss or in no conservation of moisture. Many other studies have shown similar results. It is important to know under what conditions stirring the soil is likely to

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FIG. 38. Roots of beet plants at depth of 2 to 3 inches. Cultivation to depth of 3 inches would have destroyed all of these roots.

result in loss of moisture and when in conservation. In general, when the soil is cultivated soon after a rain of ½ inch or less, moisture is likely to be lost due to hastening of evaporation by exposing more surface to the drying action of the air. In many instances, practically all of the moisture from a light rain is lost by cultivating. Even if the moisture from a light rain were not lost by stirring the soil, it would not be available to the plants because the roots are destroyed by the cultivator to the depth cultivated. Moisture is lost also if cultivation is done when a mulch is already present. The mulch is deepened and moist soil from below is brought to the surface where the moisture is lost by evaporation.

It should be noted that cultivation for the purpose of maintaining a mulch does not always result in increased yields, even though moisture is conserved. Destruction of roots by the cultivator may more than

offset the benefits from moisture conservation. In some instances, cultivation results in loss of moisture at critical periods and in others, it conserves moisture when a lower water content would be an advantage. Knowledge of these facts enables one to time his cultivating intelligently and to reduce the detrimental effects.

There is no justification for the practice of cultivating at regular intervals regardless of the conditions. When there are no weeds and a soil mulch is present, cultivation is not only an unnecessary expense, but it is usually injurious. When 3 or 4 inches of the surface soil are kept stirred, most of the roots are destroyed so that it is impossible for the plants to get moisture and nutrients in the cultivated zone (Fig. 38).

EFFECTS OF CULTIVATION ON SOIL TEMPERATURE. It is often stated that cultivation increases the absorption and retention of heat. The belief that stirring the soil results in raising the temperature is based on the fact that in the evaporation of water, heat is used. If this were the only factor involved, stirring the soil would raise the temperature whenever it resulted in conserving moisture, and would lower the temperature when cultivation increased the loss of moisture. Results of experiments reported by Thompson, by Mosier and Gustafson, by Merkle and Irvin, by Bouyoucos, and by many other investigators, show that during the growing season, cultivation results in reducing the temperature. Usually the difference is small and probably of little practical significance. The compactness of the surface of the uncultivated soil probably accounts for the higher temperature. Bouyoucos has shown that the compact soil is a better conductor of heat than is a loose, dry layer of soil.

EFFECTS OF CULTIVATION ON NITRIFICATION. Many studies have been made on the effects of cultivation on nitrification, and the results are somewhat conflicting. In some cases, nitrification was increased by stirring the soil, and in other cases, there was no significant difference between cultivated and uncultivated soil. In the writer's studies on a sandy loam soil at Ithaca, New York, there was no consistent advantage in favor of cultivation as compared with scraping the soil, as far as nitrification is concerned. Merkle and Irvin, working with a Hagerstown silt-loam soil in Pennsylvania, found that "nitrification proceeded as rapidly on the scraped plots as on plots that were cultivated three to eight times." On the other hand, Lyon found that nitrates averaged higher on cultivated plots than on comparable scraped plots of Dunkirk silty clay soil at Ithaca, New York.

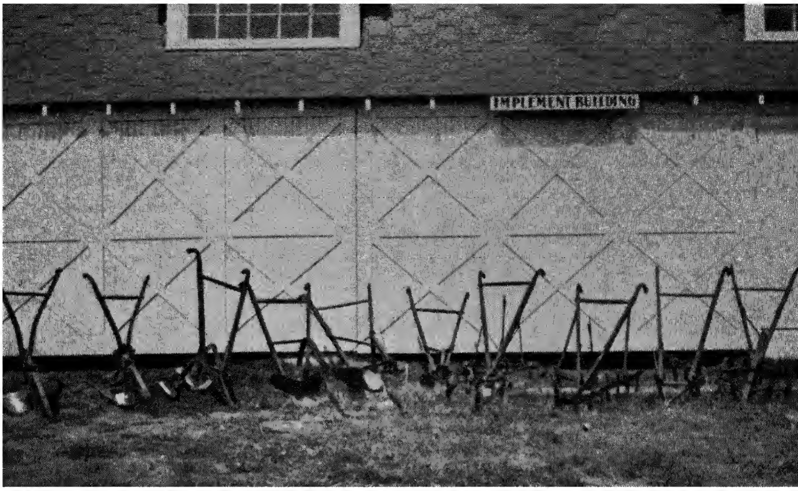

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FIG. 39. One-horse implements commonly used in the South. Left to right. Single shovel stock, with 18-inch sweep; single shovel stock with 24-inch heel-sweep; double-shovel; 10-inch middle buster; 12-inch (two horse) turning plow; 8-inch turning plow; Planet Junior cultivator; "V" or top-harrow; side-harrow; and "G-whizz" or spring-tooth cultivator

Any increase in nitrification resulting from cultivation would be brought about by increasing aeration, or by providing better moisture or better temperature conditions for the growth of nitrifying bacteria. Some investigators have shown a positive correlation between soil moisture and nitrates, while others have shown no relation. Since the soil mulch does not always have the same effect on moisture conservation, one might expect that its effect on nitrification would vary with conditions. On heavy soils, cultivation to break the surface crust usually increases aeration and this frequently results in increasing nitrification. On most vegetable soils, cultivation is seldom of much importance from the standpoint of soil aeration.

CULTIVATING IMPLEMENTS AND TOOLS. Vegetables are cultivated by all of the types of horse-drawn and tractor cultivators that are used for cultivating other intertilled crops and, in addition, hand cultivators and special garden tractors are used. Hand cultivators, of the wheel-hoe type, are used mainly for cultivating small growing crops produced intensively. Tractor cultivators range in size from the small garden tractor to the large-sized farm tractors. The heaviest

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FIG. 40. Popular two-horse implements used in the South. From left to right: Combination rotary-hoe and culti-packer; single-row stalk cutter, one-row walking cultivator, 24-inch sulky disk plow; single-disk harrow; and combination seed drill and fertilizer distributor.

tractors are not well suited to cultivation of vegetables. Some of the smaller farm tractors do satisfactory work in cultivating such crops as potatoes, cabbage, tomatoes, and other crops that are grown in rows far enough apart to give ample space for wheels.

Although garden tractors have not come into general use in the South, they are being used to some extent in intensive gardening to take the place of the wheel hoe and the lighter types of horse-drawn cultivators. A careful operator can do practically as good cultivation with a garden tractor as with a wheel hoe and better than with a horse-drawn cultivator. These tractors can be used also for pulling gang seeders.

Various kinds of attachments are used on all of the types of cultivators mentioned. The common attachments and kinds of one-horse cultivators used in the South are shown in Figure 39, while popular two-horse implements are shown in Figure 40. The sweep, commonly used in the South, and the blade attachments, such as are employed on hand cultivators, are efficient in controlling weeds and are less destructive to the roots than are the shovel and teeth attachments. One of the

most popular general purpose tools in the South is the two-horse one-row riding or walking cultivator which, with its various attachments, can be used in bedding, covering seed, smoothing, and cultivating (Fig. 41).

WHEN AND HOW TO CULTIVATE. Weed control is the most important function of cultivation; therefore, the work should be done at the time most favorable for killing weeds. The best time to kill weeds is before they have become established, since they are most easily killed when they are small. It is important to destroy the weeds before they compete seriously with vegetable plants for moisture, nutrients, light, and air. Cultivation given at the time weeds are breaking through the surface is the most efficient, since at this time they are not well established, and merely breaking the surface of the soil will destroy them.

Cultivating should be done as often as necessary to prevent weeds from injuring the crop. This requires frequent cultivation when conditions are favorable for the germination of weed seeds, as after a rain or after the application of irrigation water. The best time to cultivate after a rain, as after the application of water, is when the soil is dry

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FIG. 41. The two-horse one-row walking or riding cultivator is a popular implement in the South.

enough to crumble and not so dry as to break up into lumps. If cultivated when too wet, most classes of soils, except the sands and loose mucks and peats, will bake on drying; and, if allowed to get too dry, the surface will have already become baked and hard and will not crumble when broken up. Shallow cultivation is preferable to deep cultivation under most conditions. Practically all of the benefits derived from cultivation are obtained through shallow tillage, and such tillage results in a minimum of destruction to the roots. Some vegetable growers practice deep cultivation when the plants are small, with the idea that the breaking of the roots near the surface will result in greater development of roots below the depth cultivated. Experimental evidence obtained by Moore on potatoes indicates that this is a mistake and that destroying the surface roots does not "make the roots go down."

Under most conditions, if sufficient cultivation is given to control weeds, it will be enough to accomplish all other purposes. Cultivation to form a mulch may be desirable when a hard crust forms on the surface and when cracks develop; however, deep cultivation may do more harm than good, even under such conditions. It is certain that no good is accomplished by cultivating when there are no weeds and a mulch is already present.

Rotating

The term "crop rotation" may be defined as the growing of two or more crops in regular sequence on the same land during a period of years. Rotation may cover a period of 2, 3, or more years. When two or more crops are grown in sequence on the same land in one year, the term "succession cropping" is used. Crop rotation is of importance in disease and insect control and in making the best use of the resources of the soil.

This chapter discusses the principles of rotation primarily, while the special crop chapters contain specific recommendations concerning this subject.

ROTATION AS A FACTOR IN DISEASE AND INSECT CONTROL. Some diseases can be controlled by a system of rotation in which the host plants are grown on the same land only once in a period of 3, 4, or more years. Rotation is most effective in disease control with those organisms that live in the soil only 1 or 2 years. Club-root of cabbage and other cruciferous plants is an example of a disease that can be controlled by rotation, provided no cruciferous crops

or cruciferous weeds are allowed to grow for at least 3 years; a longer rotation is desirable where club-root is serious. Some diseases, such as the potato scab and onion smut, cannot be controlled by ordinary rotation as the organisms involved live in the soil for many years. In planning a rotation system, one needs to know what kinds of plants are attacked by a given organism. Some attack only one kind of host plant, others attack all kinds of plants within a genus, and still others are not limited to a given family of plants. Club-root affects many kinds of cruciferous plants, and the nematode disease is serious on a large number of crops representing many families.

Rotation is an aid in insect control, especially of those kinds that feed on one kind of crop only and those that are unable to move very far. With most insects, a short rotation is as good as a long one, since they die soon after emergence if the food plants are absent.

ROTATION AS A FACTOR IN SOIL MANAGEMENT. Rotation is of importance in soil management, since crops differ in their requirements for nutrients, in the extent and distribution of the root system, and in the effect on soil acidity and on other factors. It is a fairly common belief that certain crops are "hard on the land," and it is well known that crops differ in their effects on the yield of those which follow. Hartwell and his co-workers, under Rhode Island conditions, have shown that onions produced a small yield following certain crops such as mangel beets, rutabagas, cabbage, buckwheat, and potatoes and a relatively large yield following Red Top, Timothy, and a combination of these. Buckwheat, on the other hand, produced a very large yield following rutabagas and a very small yield following corn and millet. In general, the crops which had the most depressing effect on the yield of onions had the opposite effect on buckwheat. The large difference in yield of these two crops following the various crops is probably due to their varying effect on soil acidity and on the quantity of nutrients removed. It was found that the lowest yield of onions followed those crops which removed the largest quantity of deficient nutrients and the largest yield followed the crop which removed the smallest quantity of nitrogen and phosphorus. It was not universally true, however, that the crops which removed the largest quantities of the deficient nutrients were the ones which had the greatest depressing effect on the succeeding crop.

Soil acidity is affected differently by different crops and this may account for considerable variation in yield of crops that are sensitive

to acidity or conditions associated with it. It was found in the Rhode Island studies, mentioned above, that the yield of onions was highest following those crops giving rise to the least acidity. When the acidity was reduced by liming, the effects of various crops on the yield of onions following was much less divergent. With optimum quantities of nutrients and with favorable soil reaction, a large part of the depressing effects of the crops on the yield of those following largely disappeared. It appears, therefore, that supplying adequate quantities of nutrients and maintaining a favorable soil reaction would eliminate much of the depressing effect of a given crop on the one following.

ORDER OF CROP ROTATION. No definite system of rotation can be given that would be satisfactory under a wide range of conditions, but there are a few principles which should be observed. In order to utilize fully the resources of the soil, it is desirable to alternate shallow-rooted plants with deep-rooted ones, and to follow crops that supply organic matter to the soil with those that favor its decomposition. The rotation should be so planned as to give as much time as is feasible to the growing of soil-improving crops between the time of harvesting one crop and the planting of the next one on the same land. In most of the large commercial vegetable-growing regions of the South, the soil-improving crop should be grown in the summer, and turned under in preparation for fall or winter crops. Where soil erosion is a serious problem, it is important to have a soil-improving crop on the land whenever it is not occupied by a money crop. This is especially important in regions where the land is idle during the winter.

Where vegetables are grown in rotation with general farm crops, it is advisable to follow a hay or pasture crop with corn or cotton rather than with vegetable crops. Small growing crops, such as beets, carrots and other root crops, lettuce, and celery, should be preceded by a cultivated crop because of the weed factor. Weeds are less likely to be serious following a clean-cultivated crop than following a hay or pasture crop.

In planning the order of crop rotation, attention should be given also to disease and insect control as mentioned in a previous paragraph.

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10

IRRIGATING AND MULCHING

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Adequate soil moisture is essential to the production of most vegetable crops. In addition to the direct effect on plant growth, water often aids in dissolving fertilizers and soil nutrients, and plays an important part in biological activities. Sources of the soil's water supply are: (1) Direct precipitation, (2) surface drainage water, and (3) underground water, the first being by far the most important. Man has supplemented these natural sources with various forms of irrigation, by which the grower practically controls moisture conditions of the soil in arid and semiarid regions. Besides irrigation, other means of moisture control are: (1) The addition of organic matter, which increases the water-holding capacity of the soil, and (2) the use of mulches, which usually retard evaporation.

Irrigating

In 1929 there were 79,654 acres devoted to the production of irrigated vegetable crops in the southern states. This acreage was divided between Arkansas, Louisiana, Oklahoma, and Texas (Table 14). Texas had 76,788 acres in vegetable crops under irrigation, or 96.4 per cent of the total, and 14.8 per cent of the total acreage devoted to irrigated vegetable crops in the 19 leading irrigation states, including California.

TABLE 14. ACREAGE OF IRRIGATED CROPS IN THE FOUR SOUTHERN IRRIGATION STATES COMPARED WITH THE TOTAL ACREAGE IN ALL IRRIGATION STATES [1]

STATE	ALL CROPS	VEGETABLES	PERCENTAGE OF TOTAL IRRIGATED ACREAGE DEVOTED TO VEGETABLES
Arkansas	146,910	1,337	0.9
Louisiana	400,375	1,325	0.3
Oklahoma	2,109	204	9.7
Texas	594,287	76,788	12.9
Total (4 Southern states)	1,143,681	79,654	7.0
All states (19)	14,633,252	518,835	3.5

[1] From fifteenth census of the United States — *Irrigation of Agricultural Lands.*

The South in general does not depend on irrigation to the extent that some of the western states do. Rainfall is more abundant, and irrigation is thought of more as an insurance against crop loss from drought than as a means of growing the crop. In the four southern states where irrigation is regularly practiced, the operation is as important as any other cultural practice, and often more so. It not only directly affects the crop itself and creates problems of soil management, but it also involves considerable expense.

SOURCES OF WATER.[1] Water for irrigation may be obtained from streams, lakes, wells, springs, and stored storm water. In most states where irrigation is practiced, definite laws and regulations pertaining to the use of water for irrigation purposes have been set up. These regulations should be known and understood before a grower proceeds to spend money on irrigation equipment. Water may be diverted from streams, lakes, or reservoirs through gravitation or by means of pumps. Some wells are overflowing, while others require pumps to lift the water. A farmer may use one or more sources and systems in obtaining water for irrigation. Costs obviously vary greatly, and they may be divided into two parts: (1) The costs of initial purchase and installation of equipment; and (2) costs connected with actual application of the water to the land. Where water is obtained from flowing wells or springs, or diverted from streams or lakes, the initial expense may be comparatively low. In the case of stream diversion, the expense is often borne by a group of people. However, when powerful pumps are required to raise the water, initial expenses become high. The cost of drilling a well, installation of a pump and motor, as well as building a reservoir for temporary storage, may easily amount to $5,000 or more. The expense of applying water to the land is more or less constant every year.

APPLYING WATER. Water can be applied usually by one of three methods: (1) Surface irrigation, (2) sub-irrigation, and (3) spraying. The first is by far the most common, and is practically the only method used on the irrigated lands listed by the Bureau of the Census. Applying water by sub-irrigation is only feasible under certain soil conditions, and is not commonly practiced. As an insurance against drought, spray irrigation is used more in the eastern states than in other sections. Since care in choosing equipment may reduce initial cost and insure practical results, a grower should determine which system best suits his

[1] U. S. Dept. Agr. Farmers' Bull. 1404; and U. S. Dept. Agr. Tech. Bull. 254.

particular condition, and insist that it is laid out to the best advantage. The source and amount of water available, topography of the farm, soil type, prevailing climatic conditions, are some of the factors to be considered.

The actual application of water also requires special training on the part of the grower. The amount of water to apply, the frequency of its application, the various methods best suited to the different crops, as well as soil management, are important considerations. The mere application of water to the soil far from solves a grower's problems; indeed, it may add to them. For example, irrigation sometimes leads to drainage difficulties and to salt accumulation; therefore, adequate drainage is just as necessary as a sufficient water supply. On farms where irrigation is consistently practiced, there is a danger that salts, harmful to plant growth, may gradually accumulate in the surface layer of soil. Various factors such as poor drainage, water with a high salt content, and too frequent light irrigations, may all contribute to this condition. While proper methods of soil and irrigation management aid in preventing such salt accumulations, they tend to occur under some conditions, regardless of precautions taken. However, in many locations such difficulties are not encountered, and through intelligent management, some soils retain their productive qualities after many years of irrigation.

In general, regardless of the method of irrigation, sufficient water should be applied to moisten the ground thoroughly. Frequent inadequate irrigations should be avoided unless the primary purpose of the irrigation is to cool the soil. In actual practice, the quantity of water applied and the frequency of irrigation will depend on several interacting factors involving the crop, the soil, and the weather. In surface irrigation, the furrows or the areas between the borders are usually made of sufficient length to allow proper penetration and horizontal movement of water by the time it reaches the lower end. A common application is equivalent to a solid sheet of water 3 to 4 inches deep, which is usually more than sufficient.

SURFACE IRRIGATION.[1] As the name implies, in surface irrigation the water is made to flow over the soil surface. Wherever vegetable crops are irrigated by this system in the South, either the border or the furrow method is generally used. In the former system, which is more adapted to land having a gentle slope, borders 6 to 8 inches high and

[1] U. S. Dept. Agr. Farmers' Bulls. 1243 and 1635.

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FIG. 42. A seed bed being irrigated with the furrow method of surface irrigation. Rows just to left of stake are finished, and ends have been filled in to prevent the further flow of water. To the far left water is also flowing down some more rows of the seed bed.

150 to 300 feet long are thrown up every 5 to 12 feet apart. These borders follow the general contour of the land, and the entire area between them is flooded during irrigations. With more rolling pieces of ground, the ridge and furrow system is usually more desirable (Fig. 42).

Correct preparation of the soil surface is most essential in any system of surface irrigation. It saves loss of time during actual irrigation, results in a more even distribution of water, reduces waste, and leads to the production of larger crops of better quality. Grading after plowing reduces the soil to an even plane surface, by removing the knolls and filling the depressions, but the entire area is not reduced to the same level. A general slope is desirable, the amount varying with each locality. Manufactured levelers (Fig. 43) as well as homemade wooden floats or drags are commonly used for this final smoothing process.

When the initial cost for wells, pumps, and accompanying equipment is not so large, surface irrigation requires only a moderate investment. If the supply of water is sufficient, this method is excellently adapted

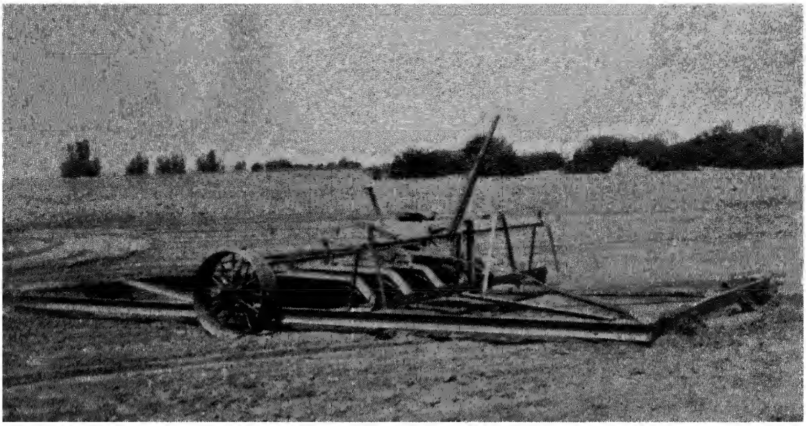

FIG. 43. A manufactured leveler often used for smoothing the soil surface prior to making the borders or the ridges and furrows in surface irrigation.

to irrigating immense areas of ground. Among the disadvantages are: (1) The necessity for constant attention, (2) the tendency for soils to crust and bake, and (3) the tremendous losses of water by seepage in supply ditches.

SUB-IRRIGATION.[1] In sub-irrigation, water is added to the soil in such a way that it permeates the soil from below. Sub-irrigation requires an abundance of water, a sandy loam top soil through which water will move freely by capillary attraction, and an impervious subsoil which will hold the water. At the same time, sub-irrigated land requires adequate drainage. The large amount of water required and the great expense involved in the laying of tile pipes (although sub-irrigation does not necessarily involve the laying of any structures) are disadvantages to this system. Advantages include the maintenance of an undisturbed soil mulch, and lack of trouble resulting from soil baking. In actual practice, sub-irrigation is sometimes difficult, justifying considerable investigation of existing soil conditions and the water supply before such a system is installed.

SPRAY IRRIGATION.[2] Spray irrigation involves the use of a system of pipes in which the water is conveyed to the fields under pressure, and there sprayed on the crops (Fig. 44). Advantages of this system include: (1) Adaptability to all soils and soil surfaces, (2) utili-

[1] Tex. Agr. Ext. Cir. 97. [2] U. S. Dept. Agr. Farmers' Bull. 1529.

zation of amounts of water entirely inadequate for surface or subirrigation, and (3) minimum attention requirements. A spray irrigation system is often excellent insurance against drought in more humid regions, where the crops being grown warrant the heavy expense of installation and the cost of water itself. Under ordinary arid climatic conditions, it is not successful, as it delivers water too slowly and in insufficient quantities.

Mulching

A mulch is created whenever the soil surface is artificially modified. Coverings of straw, leaves, refuse, or paper, and even a loose layer of soil produced by cultivation, are all mulches. Mulching with materials other than the soil itself is not very extensively practiced. In the nonirrigated sections of the South, straw and pine needles are commonly used as mulches for strawberries. In recent years, paper has received considerable attention as a mulch for various vegetable crops, the North giving it more attention than the South.

PURPOSE OF MULCHING. The chief purpose of mulches is to conserve moisture, but they are also used to insure clean fruit, control weeds, hasten maturity, and to increase yields. Paper mulch, more than any other kind, is reported to be effective in all of these uses.

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FIG. 44. A crop of cabbage under overhead spray irrigation. The lines of parallel pipes are placed so that there will be complete coverage between each pair, but with a minimum overlapping of spray.

EFFECT OF MULCHING. Because of the great interest in paper mulch, numerous observations have been made during the last few years as to its effect on soil moisture, soil temperature, and soil nitrates, as well as its influence on weed growth, and the various processes and characteristics of the crop.

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FIG. 45. A paper mulch experiment with vegetables. Upper, soon after planting. Lower, the same field some weeks later. Notice more vigorous growth in rear foreground where mulch paper is used

Effect on the Soil. Most workers have found that the mulch conserves moisture directly by preventing evaporation, and indirectly by controlling weeds. In arid and semiarid regions, where the soil moisture is low to begin with, mulch is no substitute for irrigation and in some cases makes irrigation difficult. Experiments in three widely separated localities have indicated that there is increased nitrification under mulch paper. Soil temperatures are usually several degrees higher under ordinary black colored paper mulches than under similar unmulched conditions. With papers of lighter color, and under certain climatic conditions, temperatures under a mulch may be lower. Since soil and most other mulches are not so impervious as paper mulch, their effects on soil conditions are probably not so striking.

Effect on the Crop. Warm-season crops, such as cucumbers, muskmelons, eggplants (Fig. 88), and peppers, usually respond to paper mulch by maturing earlier and by yielding more. Quick-maturing spring crops also are often benefited (Fig. 45). The response of both these types of crops is probably due to higher soil temperatures. The quality of such crops may be improved by paper mulch, the products being larger, cleaner, and containing fewer culls. When growing conditions are already favorable, however, paper mulch rarely improves them, and may indeed affect the crop adversely. Such cool-weather crops as onions, lettuce, beets, cabbage, and cauliflower have been reported as responding rather poorly to paper mulch. Of all the mulches, paper mulch probably has as much or more effect on plant growth.

MAKING THE MULCH. The time at which mulches are made depends on the type of mulch as well as the kind of crop. In general, most mulches are made after the crop is planted.

Paper Mulch. Paper mulch is usually laid strip by strip as the rows of seeds or plants are set out. It can also be laid first, and then the planting done through holes cut in the paper. Wire staples, steel rods, or wood lath, placed at intervals across the paper or along its edges may be used to hold down the mulch. Special equipment has also been developed to lay the paper and cover the edges with a narrow bank of earth all in one operation. Anchoring with soil is usually cheapest, but not always the most suitable. The cost of paper mulch is very high, especially with complete coverage, and its use is warranted only on crops of high value which are known to respond well. The heavier grades of paper should be used, and paper containing volatile or water-soluble materials which are harmful to the plant should be avoided.

Other Mulches. Straw, leaves, pine needles, and similar mulches are usually applied after the crop is well established. Such mulches are not commonly used with vegetable crops. However, many growers like to maintain a good soil mulch, which is fully discussed in Chapter 9, page 107.

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11

CONTROLLING DISEASES AND INSECTS

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Importance of Pest Control

Plant diseases as well as insect pests cause heavy losses every year among southern truck crops. Such losses are three-fold: (1) Damping-off and dying of seedlings in either seedbeds or fields, resulting in poor stands; (2) losses and reduction in yields because of various diseases and insects which attack the roots, stems, foliage, or fruit; and (3) reduction in quality because of partial disfigurement of parts, or the whole plants from diseases or insects. Losses from diseases or insect pests are also additional burdens to cost of production, thus reducing the profits of the growers. The saying, "A stitch in time saves nine," well applies to the control of diseases and insect pests. It is usually easier to prevent their introduction than it is to try to eradicate them.

There are two general classes of diseases: (1) Non-parasitic and (2) parasitic. The first is caused either by the unadaptability of a given plant to certain environmental conditions or by adverse soil, weather, or artificial conditions; and the second is caused by parasites which, with very few exceptions, belong to very low forms of plant life and are known as fungi and bacteria.

The largest number of diseases are non-parasitic in origin. They will be briefly mentioned for the information of the reader. They include such common ailments as, (1) deficiencies of nutrients in the soil; (2) excesses of soluble salts in the soil; (3) improper acidity or alkalinity of the soil; (4) deficient or excessive soil moisture; (5) improper air relations as in the black heart of potato; (6) high and low temperature injuries, such as sun scald, crown rot, and frost injury of numerous plants; (7) unfavorable light conditions, such as prolonged cloudy weather, too much shade, or intense light; (8) diseases due to manufacturing and industrial processes, such as cement dust injury, injury of vapor or dust from tarred roads, and injury from illuminating gas and smoke in the air; and finally, (9) diseases due to germicidal seed treatments or to sprays and dusts.[1]

[1] Heald, F. D., *Manual of Plant Diseases*, Text, McGraw-Hill Book Co., New York, 1933.

An intelligent attempt at controlling parasitic diseases and insects requires an understanding not only of the life history of the particular disease producer or plant pest, but also of environmental conditions which are favorable or unfavorable to the hosts or parasites. Of these should be mentioned soil and air temperatures, soil moisture, nutrients, soil acidity or alkalinity, and cultural practices. Careful consideration should be given to these:

SOIL. Many soils devoted to truck crops either should be on the "sick list" or convalescing, or in a stage of non-productiveness. Such soils frequently are overrun and infested by insect pests, or various organisms which cause plant diseases. Any attempt to grow truck crops profitably under such conditions is deliberately placing the grower under disadvantages. When a soil is sick, it may be badly infested, for instance, with various wilt-producing fungi, such as watermelon wilt, *Fusarium niveum;* cabbage wilt, *Phytomonas campestris;* or okra wilt, *Fusarium vasinfectum.* Such soils should be given a rest from the particular susceptible crop, and be devoted to others which are more resistant or immune. Soil infested with other pathogenic organisms should be treated in a similar manner.

SEED. Quite often a serious plant disease may be introduced into a new field or a new locality by infected seed. This may happen, for instance, with anthracnose of beans, fusarium wilt of tomatoes, peppers, or eggplants. Such diseases are frequently carried in the interior of the seed; others may be carried as spores adhering to the exterior of the seed coat. This involves using non-infected seed, or employing seed treatment. The control of diseases which attack the parts of the plants above ground requires certain sprays or dusts, in which case timeliness and thoroughness of application is a battle half won. This involves a familiarity with the cause or causes of the diseases or insect pests which infest the crop needing protection. Furthermore, a practical working knowledge of the life histories of disease organisms and insect pests which attack plants is desirable in order that the spray or dust may be applied at a time when it will be most effective. This also involves the use of proper machinery and materials. For instance, sucking insects, such as plant lice, cannot be controlled by spraying or dusting the infested plants with Bordeaux mixture. Neither will lead arsenate control any of the powdery or downy mildews or other parasitic diseases which affect parts of the plants above ground.

Methods of Control

It should not be supposed that all parasitic plant diseases or insect pests, irrespective of types or forms, can be controlled by any one single method. Certain methods may apply broadly to various plant diseases or insects, while other pests may require specific control measures.

The more important vegetable diseases and insect pests and methods of control are contained in this chapter. Special crop pests and control measures are specifically discussed in the crop chapters in Section II.

USING SANITARY METHODS. It should not be assumed that it is feasible or advisable to grow crops too long on the same land. Sooner or later, important disease producers or insect pests may infest the land and make it unfit or unprofitable. With truck crops as with others, a system of rotation should be adopted in which a crop is grown on the same land once every second or third year. Ordinarily, it is best to turn under all the organic matter possible. When soil becomes infested by various plant parasites or insect pests, affected plants should be destroyed by fire.

PICKING BY HAND. Picking by hand is desirable only when there is no other method of control or where labor costs are low and the area to be freed of insects is small. Tomato horn worms, the Colorado potato beetle, squash bug, and lubber grasshoppers are insects that may be controlled by hand picking.

DISINFECTING THE SOIL. Soil disinfection is expensive and should not always be recommended on large-scale cropping. It is frequently used to good advantage in seedbeds and cold frames. By this means, the grower may use the same bed several years without a change of soil. Infested soils may be disinfected by the use of formaldehyde solution or by steam. Soils sometimes may be treated against insects by fumigation.

FUMIGATING. This is practicable only where the return per unit is large and where no other control method is possible. Calcium cyanide is used in the control of wireworms and other soil-infesting insects. Carbon bisulfide emulsion is also used in special cases, such as the control of root maggots and white grubs. Hot water may also be used in controlling soil insects, but each method has its limitations because of the expense of application.

TREATING SEED. A short cut to soil disinfection consists in treating the seed before planting. The seed is dipped or soaked in a

standard dust or liquid disinfectant. This method offers a certain amount of protection by preventing the harmful soil microorganisms from attacking and destroying the germinating seed before or as they break through the surface of the soil crust. Seed treated with the proper disinfectants usually germinates more quickly than untreated seed. Seeds may be soaked for short intervals in a solution of bichloride of mercury, in a solution of formaldehyde, or dusted with Cuprocide or cuprous oxide, Ceresan, or others which by trial methods have proved useful.

SPRAYING OR DUSTING. Sprays or dusts are intended as protection against infection from plant diseases or attacks from insects. The material to be used will depend on the disease or insect pest to be controlled. In general, all sprays or dusts which are used to control plant diseases involve the use of various forms of copper, sulfur, or a mixture of both. For insect control, the materials to be used will depend on whether they are the sucking or biting types.

A great many materials are available for the control of insects with biting mouth parts. Of these, arsenate of lead and compounds containing rotenone are the most desirable. Rotenone is a plant poison obtained from the roots of derris, cube, and devil's shoestring. It is especially adapted to the control of insects which affect vegetables because it is not poisonous to man. Rotenone may be applied either as a spray or a dust. Calcium arsenate may be applied to vegetables which will tolerate arsenical compounds, but it should not be applied to legumes. Magnesium arsenate can be applied to leguminous plants, but should not be used on other vegetables since it is not as effective as the other arsenicals.

Barium and sodium fluosilicate are used in the form of dusts diluted with lime or sulfur for the control of flea beetles, blister beetles, and cucumber beetles. For the control of insects with sucking mouth parts, such as plant lice, thrips, and leaf hoppers, nicotine sulfate, or soap, are used. Nicotine sulfate is expensive, but, where its use is not prohibitive because of cost, it is very effective.

There are definite limitations to the use of such poisons as lead arsenate, calcium arsenate, magnesium arsenate, Paris green, and the compounds of fluorine because of the danger to the consumer from poisonous residues. These materials should not be used as dusts or sprays when there is danger of poison remaining on the edible portion of the plant at harvest time. Legal restrictions have been placed on interstate ship-

ments and on the sale of fruits and vegetables which carry residues that endanger the consumer.

Spraying, as a rule, is more effective than dusting in the control of insects and plant diseases.

In spraying, the insecticide or fungicide can be more thoroughly applied to all surfaces of the plant. On the other hand, in the case of low-growing vegetables such as turnips and melons, where it is difficult to get a spray nozzle below the leaves of the plant, it is more economical to apply a dust. Dusting may also be more practical where the land is hilly or where there is an inadequate water supply. A smaller amount of the material per acre or unit area is necessary when the material is applied as a spray, but a greater length of time is required to apply it; so, on the whole, the use of dust may be cheaper than spraying when large areas are to be covered.

SPRAYING AND DUSTING EQUIPMENT. The type and capacity of the spraying machine will depend on the amount of territory to be covered. On the whole, it will not be economical to use small atomizers or bucket pumps in spraying vegetables. A knapsack sprayer or compressed air-type hand sprayer may be used when the gardening operation is confined to a small area; but even on a small area, a two-wheeled cart with a capacity of 20 or 25 gallons will be found much more

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FIG. 46. Dusting a large field of eggplants with a power duster for control of fruit rot and flea beetles.

satisfactory than the smaller types of spraying outfits. If the operation demands an outfit of larger capacity, then the operator should provide himself with a traction sprayer or a power spraying machine. These will be found more effective and more satisfactory to operate than barrel pumps or the smaller types of spraying machines.

Dusting on smaller areas can be done effectively with small hand-operated dusting machines (Fig. 48). On larger areas, it is necessary to resort to the use of traction outfits which use chains from the wheels of the machine to operate the dusting equipment (Fig. 46). In some cases, it is practicable to operate a dusting machine with a gasoline motor.

USING TRAP CROPS. Trap crops are desirable controls when it is not possible to use an insecticide or when the covering of the insect is so hard that insecticides will not penetrate it.

For the control of such insects as the harlequin cabbage bug, which overwinters in the adult state, a crop which will not be easily winter killed, such as kale, should be planted in the fall. When the adults emerge from hibernation and collect on the plants, the entire crop may be sprayed with pure kerosene. In other cases, where the insect has a preferred host, that crop may be planted before planting the main crop. After the insects collect on the preferred host plants, they may be thoroughly sprayed and destroyed with an insecticide before they attack the chief crop. In some instances, several rows of the preferred host may be planted at the same time the main crop is planted, and a few additional rows of the preferred host are planted at 2-week intervals thereafter.

Cantaloupes and cucumbers may be protected from attacks of the pickle worm by planting squashes as a trap crop. In such a case, either the blossoms should be picked and destroyed or the entire squash vines should be destroyed as the later-planted cantaloupes come into bloom.

GROWING RESISTANT VARIETIES. Perhaps the cheapest method in controlling troublesome plant diseases or insect pests is to grow resistant strains or varieties of crops. This has been accomplished with tomatoes, for instance, as several varieties have been developed for their resistance to Fusarium wilt, *Fusarium lycopersici*. The same has been accomplished with watermelons, several Fusarium wilt-resistant varieties having been developed by the Iowa and Florida Experiment Stations. The possibility of developing resistant varieties of truck crops against other plant diseases offers much promise.

Important Diseases and Preventive Measures

DAMPING-OFF. Damping-off under conditions of the South may be caused by one or a combination of several soil-borne organisms, such as species of *Rhizoctonia* and *Fusarium*. These organisms can survive on decayed organic matter in the soil, and are able to attack young seedlings or older plants.

Damping-off is common in seedbeds or cold frames, or in the field. In some parts of Mexico or Texas, for instance, it is difficult to produce snap beans during summer months or the early fall, because the young seedlings damp-off.

Under seedbed conditions, damping-off may be controlled by treating the seed before planting, proper thinning of seedlings, allowing the necessary ventilation, and by judicious watering.

ROOT KNOT. Root knot, caused by the nematode *Heterodera marioni*, is discussed on page 218.

BACTERIAL WILT. Bacterial wilt is discussed on page 217.

STEM ROT. Stem rot of different vegetables is usually caused by various fungi, but more often by Rhizoctonia, causing lesions or cankers

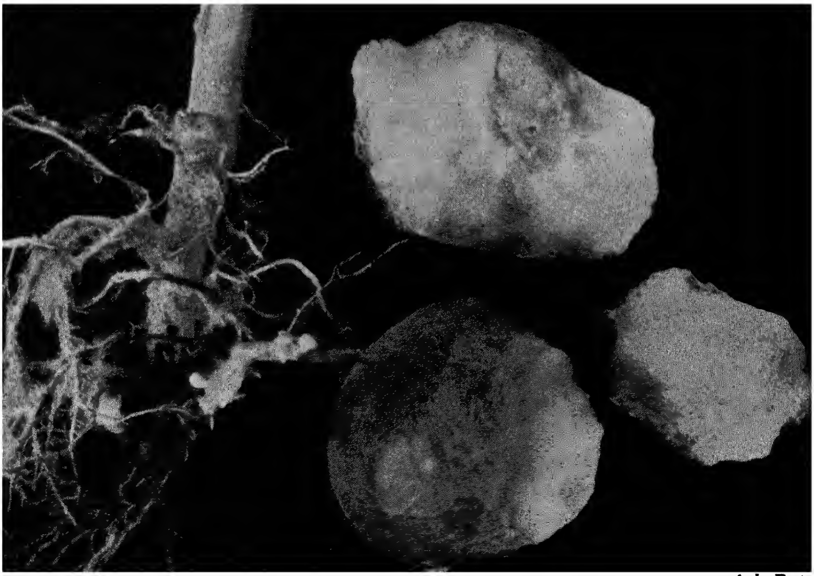

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FIG. 47. Irish potato tubers partly covered by the whitish moldy rot-producing fungus, *Sclerotium rolfsii*, that attacks many other plants.

on the crowns, stems, and roots of young seedlings and even older plants. Stem rot may also be induced by species of Fusaria or Colletotrichums. The trouble may be controlled by seed and soil treatments, by spraying with 4–6–50 Bordeaux mixture (in terms of hydrated lime) to which may be added 4 pounds of wettable sulfur to each 50 gallons of the Bordeaux. The wettable sulfur merely acts as a spreading agent and also increases the toxicity of the Bordeaux.

SCLEROTIUM ROT. This is a serious trouble of southern-grown truck crops and is caused by a fungus, *Sclerotium rolfsii.* The trouble is common on young seedlings of beans, cantaloupes, peppers, cucumbers, and other plants. The same fungus is also capable of attacking older and mature plants and is then spoken of as Southern blight. Irish potatoes, tomatoes, or cantaloupes, for instance, sometimes suffer severely from this disease. Affected plants are covered by a snow-white, fan-shaped fungus growth around the affected parts (Fig. 47), followed by an abundance of resting bodies or sclerotia which are the size, shape, and color of mustard seed. These sclerotia enable the fungus to survive from year to year. Sclerotium rot or Southern blight is usually favored by the presence of large amounts of undecayed organic matter in the soil. The sclerotia are known to withstand exposure to weather conditions, but deteriorate rapidly when they are deep in the soil. The disease may be controlled by very deep plowing in which all the undecayed organic matter, affected plants, and sclerotia are turned under at least 6 to 8 inches. To effect control, such plowing should be done at least several months before sowing or planting the crop.

COTTON ROOT ROT. In the Southwest, Phymatotrichum, or cotton root rot, is sometimes of importance in truck gardens, particularly when such crops grow and mature during the summer months. Examples of these are okra, beets, peppers, eggplants, and Swiss chard. The disease is caused by a fungus, *Phymatotrichum omnivorum*, which is known to be very serious on cotton, but it also attacks some 2,000 or more other species of plants. The fungus survives during the winter months on infected but undecayed roots or as sclerotia or resting bodies. The Phymatotrichum fungus also produces summer spores which appear in the form of surface mats, the true function of which is still unknown. Ordinarily, fall, winter, or spring truck crops grown in the Southwest are not seriously affected by Phymatotrichum root rot, since the fungus is not so active during that time as it is in the summer. Control of this disease in truck crops consists of planting crops which

can be grown and matured during the fall, winter, and spring months. For truck crops which grow and mature during the fall and summer months, control consists of (1) practicing a 2- to 3-year rotation with resistant crops of the grass family, particularly sweet or garden corn; (2) following with clean cultivation; (3) destroying susceptible weeds; and (4) plowing under as much green manure and organic matter as is possible each year.

Other diseases peculiar to the different vegetable crops and methods of control are discussed in the special crop chapters.

Important Insects and Control Measures

PLANT LICE OR APHIDS. Plant lice are common on a great variety of plants. These insects are usually green in color, although some species are red, some yellow, and others are black. Most species are pear-shaped and all of them are soft-bodied. One of the most remarkable things about them is their tremendous powers of reproduction. The females give birth to living young at the rate of 3 to 5 every 24 hours. In from 4 to 10 days, the young females are ready to reproduce, and there may be as many as 57 generations a year. Plant lice are usually wingless as long as plenty of food is available, but as soon as they become crowded the succeeding generation develops wings and flies to a new location.

In addition to the direct injury caused, these insects also injure plants indirectly by secreting honey dew, a sticky substance which is excreted from the alimentary tract. When plant lice are abundant, this honey dew often covers the entire upper surface of the leaves. A black fungus grows in it and indirectly injures the plant, often causing the leaves to be shed prematurely.

Plant lice are most effectively controlled by nicotine sulfate which may be added to water or it may be mixed with air-slacked lime and used

TABLE 15. DILUTION TABLE FOR NICOTINE SULFATE SPRAY

NICOTINE SULFATE (PINTS)	WATER (GALLONS)	SOAP (POUNDS)	AMOUNT OF DILUTION
1	100	4	1–800
$\frac{3}{4}$	100	3	1–1,000
$\frac{1}{2}$	100	2	1–1,500
$\frac{3}{8}$	100	$1\frac{1}{2}$	1–2,000

as a dust. Thorough work must be done if any degree of control is to be obtained. Unless an arsenical is to be added, it is always desirable to add soap to the nicotine sulfate solution when it is applied. It is most effective when used at the rate of 1 pint to 100 gallons of water, and it should be used at that strength except when the return from the crop to which it is applied will not justify the expenditure (Table 15). It is best applied during warm weather, as it volatilizes more quickly when the temperature is above 70° F. Nicotine may be effectively used as a

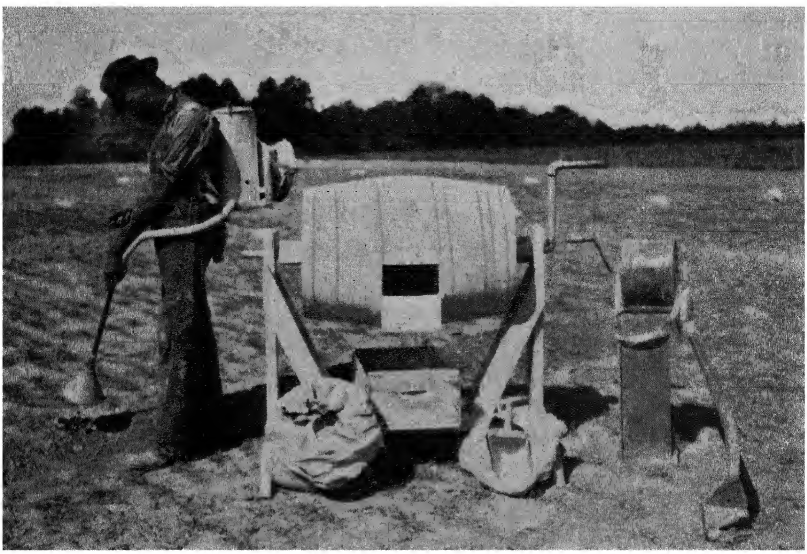

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Fig. 48. Dusting equipment: Left, bellows pack duster with cone-shape nozzle for dusting hill crops; center, a home-made barrel dust mixer; and right, a one-row crank-type duster.

dust on low-growing vegetables, such as turnips, by adding air-slaked lime. When air-slaked lime is not available, hydrated lime may be used.

To use nicotine sulfate as a dust, it is mixed in a barrel. A 6- by 8-inch opening is cut in the side of the barrel. The part cut out of the side is made into a door which is padded so that no leakage can occur. A stand is made for the barrel, and a 1¼- by 1-inch bushing is screwed securely to each end. Into the bushing at each end, a 1- by 6-inch pipe is screwed and the two pieces of pipe act as an axle upon which the barrel is rotated. A handle is attached to one end (Fig. 48).

A 2 or 3 per cent dust, if thoroughly applied, will give excellent control of plant lice. The strength of the dust desired is calculated in Table 16.

TABLE 16. DILUTION TABLE FOR NICOTINE SULFATE DUST

STRENGTH OF DUST (PER CENT)	AMOUNT OF NICOTINE SULFATE (PINTS)	AMOUNT OF AIR-SLAKED OR HYDRATED LIME (POUNDS)
1	1	50
2	2	50
3	3	50
4	4	50

CUT WORMS. There are several species of cut worms and the type of injury varies, but most of them cut off the plants at the surface or just below the surface of the ground. Very little feeding is done at any other point. Most of the injury is done at night and a careful search will usually result in the larva or worm being found coiled in the ground near the base of the plant. The larvae are smooth and usually brown or green in color. These worms are the growing stage of brown to blackish moths which lay their eggs on the stems of grasses or on weeds. The larvae which hatch from these eggs pass the winter in the ground, and, as soon as spring comes, they begin feeding.

Poisoned bran mash is the best method of control, an effective bait being made by the following formula: 25 pounds of bran, 1 pound of sodium arsenite or Paris green or white arsenic, 2 quarts black strap molasses or other cheap syrup, 3 to 6 lemons, and 2 or 3 gallons of water or a sufficient amount to make a stiff mash.

Mix the bran and sodium arsenite thoroughly, add the molasses and crushed lemons to the water, then gradually add the liquid to the bran mixture, stirring thoroughly until every flake of bran is moistened. This material may be broadcast on large areas; on smaller areas it may be broadcast or put out in small piles. In the latter case, care should be taken not to place it too close to the plants as rains may leach out enough arsenic to cause injury.

WIREWORMS. Wireworms are the larval stage of several species of click beetles. The larvae are elongate, brown worms with a tough, hard outer covering. They live underground, boring into tubers and roots and often destroying germinating seed. The adults lay their eggs in the ground, most species preferring to lay their eggs in sod. The larval stage may last as long as 3 years. In most cases, considerable

injury may be prevented by a rotation of crops; also land should not be left in sod too long at any one time. Deep cultivation of the soil in July and August will break open the pupal cells and thereby reduce the number of insects the next year. For the garden, an effective poisoned bait is made by dipping succulent plants, such as alfalfa or clover, in a solution of Paris green and then placing them under boards. In some cases where the damage is especially severe, a more expensive type of control may be used if the returns from the crop justify the expenditure. In such a case, it is desirable to keep the land free of plant growth during the previous fall and winter. In the spring, a bait consisting of beans or a miscellaneous mixture of beans, corn, and peas is planted in rows $2\frac{1}{2}$ feet apart. After the bait crop has sprouted, a furrow is plowed to a depth of about 6 inches and as close to the row as possible and granular calcium cyanide is drilled in the furrow at the rate of 100 pounds per acre; afterward the furrow is covered with the plow. The worms are attracted to the sprouting grain and are killed by the volatilization of the cyanide.

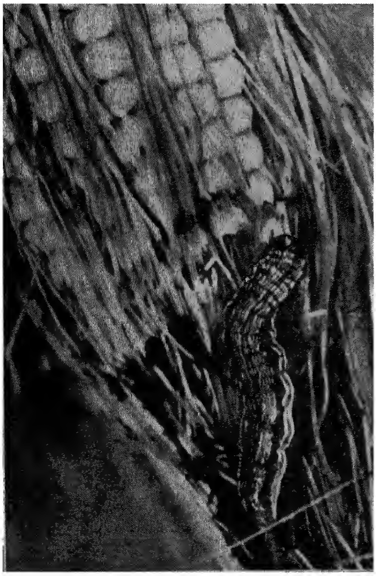

FIG. 49. The corn ear worm is destructive to corn, tomatoes, and other vegetables

CORN EAR WORM. The corn ear worm (*Heliothis obsoleta*) is destructive to a number of vegetable crops, but its damage is most severe on tomatoes and sweet corn. The corn ear worm is the larva of a light grayish brown moth (Fig. 49). The front wings are marked with dark irregular lines and there is a dark area near the top of the wing. The back wings are light in color. The winter is passed in a pupal cell from 2 to 6 inches below the surface of the soil. When spring comes, the moths emerge from these pupae and crawl up the tunnel made by the larvae before they pupated in the fall. The eggs are laid singly and, in the case of tomatoes, are deposited on the underside of the leaves, but on corn the silk is selected. After the larvae reach maturity, they drop to the ground and burrow in the soil, where they make a pupal burrow. This is

repeated for each generation. This insect may be controlled by spraying and dusting with arsenate of lead if the arsenate of lead is applied when the worms are small. However, they are difficult to control after they have attained considerable size. On sweet corn, the silks should be dusted with a hand shaker or a bellows dust gun as soon as the larvae appear. Arsenate of lead is usually mixed with equal parts of finely ground sulfur or some other carrier.

Some varieties of sweet corn have been developed which are more resistant to the attacks of the corn ear worm than others (Fig. 80, page 239).

VEGETABLE WEEVIL. This insect is a small snout beetle about $\frac{3}{8}$ inch long, which attacks turnips, carrots, spinach, tomatoes, radishes, and a few other vegetables to some extent. Heavy infestations usually occur when a succession of the preferred host plants are grown during the fall, winter, and spring. This insect can be controlled by dusting with barium fluosilicate.

SQUASH BUG (*Anasa tristis*). This insect attacks all the cucurbits, but it is especially destructive to squashes. Sometimes, in midsummer, as many as a thousand adults and nymphs have been counted on a single squash plant. The adult is about $\frac{5}{8}$ of an inch in length and has an offensive odor. It hibernates in rubbish or any convenient shelter, and begins to attack the plants as soon as the crop is well out of the ground in the spring. The female deposits brown eggs in clusters of three or four up to 50. The eggs are usually deposited on the under side of the leaves; but occasionally, a few are deposited on the upper surface. The eggs hatch in from 6 to 15 days. The young bugs are similar in appearance to the adults, but they lack wings and are soft-bodied.

The body of the young nymph is green; the legs, antennae, and beak are rose-colored; and the head and front part of the thorax are still another color of rose. In the process of its development, the young bug or nymph molts five times. At first the nymphs do not move about a great deal, but after the first molt they move around freely. When not feeding, both the nymphs and adults congregate at the base of the plant. These insects have sucking mouth parts and cause the leaves to wilt and die. When there are great numbers of them present in dry weather, they may kill the plant. They are difficult to control, because of their sucking mouth parts and hard bodies. They have a habit of crawling off the plant and hiding under clods on the ground at night.

Early in the spring before they have laid their eggs, these insects may be trapped by placing small boards or pieces of shingles in the squash patch. Each morning while it is still cool, the bugs should be collected from beneath these boards and dropped into a can of kerosene. When squashes are raised on a small scale, hand picking is also desirable. The nymphs can be killed by spraying with nicotine sulfate at the rate of 2 pints to 100 gallons of water, to which 4 pounds of soap has been added.

BLISTER BEETLES. Tomatoes, potatoes, beans, peas, melons, beets, and other vegetables are often severely damaged by these soft-bodied beetles. There are many species of them, the most common being the ash gray blister beetle and the old-fashioned potato bug or striped blister beetle. All of them are elongate, being about four times as long as broad; the head is distinctly set off from the body by a narrow neck. Their bodies contain a substance known as cantharidin which blisters the skin when an insect is crushed. Only the adult stage is harmful, since the larvae feed on grasshopper egg pods. These insects may be controlled with a dust made of barium fluosilicate diluted with lime or sulfur at the rate of one part of barium fluosilicate to 2 parts of sulfur or lime. Blister beetles may be successfully controlled by providing places in the field where no crop is planted and then placing hay or straw in such a location, so that the beetles will congregate there during the heat of the day. The infested piles of hay are burned.

FLEA BEETLES. Flea beetles are small insects which vary from $\frac{1}{16}$ to $\frac{1}{6}$ of an inch in length. There are several species of flea beetles and they are commonly known by the name of the plant which they attack, such as potato flea beetle, spinach flea beetle, striped cabbage flea beetle, and sweet potato flea beetle. Nearly all of them are oval or elliptical in outline with a small head. They feed on weeds as well as vegetables, and are pests in seedbeds as well as on plants after they have attained some growth. In most cases, the eggs are deposited in the soil in the vicinity of the host plant, but some of them deposit their eggs in small holes in the stems of the plants on which they live, while others oviposit on the leaves and leaf petioles. The larvae are small, whitish cylindrical worms from $\frac{1}{8}$ to $\frac{1}{3}$ of an inch in length, which feed on the roots or tubers of both vegetables and weeds. Pupation usually occurs in the soil. In addition to the immediate injury which they cause, they also spread fungous diseases. The adults are very active, and usually do not feed long in one spot. A plant attacked by flea beetles has the appearance of having been peppered with fine shot.

Flea beetles may be controlled by a dust made of one part of barium fluosilicate and one part of talc or finely ground dusting sulfur, depending upon the host.

CUCUMBER BEETLES. There are three common species of these beetles, namely: the striped cucumber beetle (*Diabrotica vittata*) (Fig. 50); the 12-spotted cucumber beetle, also known as the southern corn root worm (*Diabrotica 12-punctata*); and the belted cucumber beetle (*Diabrotica balteata*). These beetles work on germinating plants when

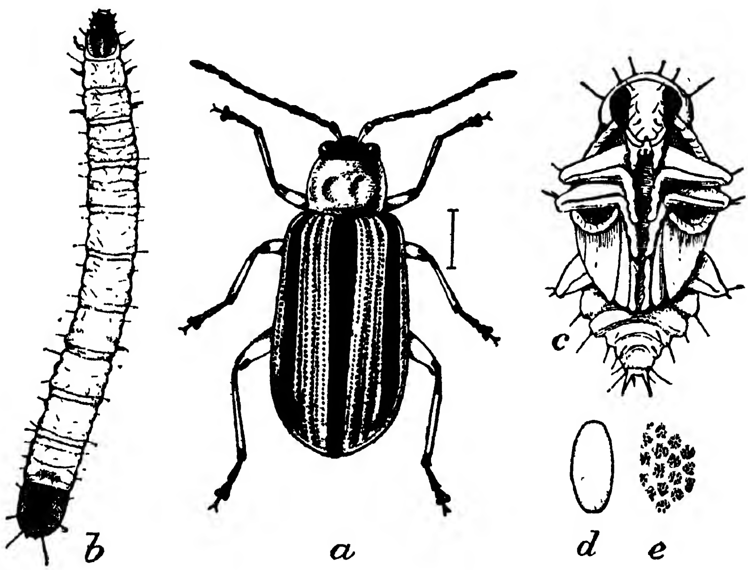

FIG. 50. The striped cucumber beetle: *a*, adult beetle; *b*, larva; *c*, pupa; *d* and *e*, eggs.

they appear above the ground, and eat off the outer surface of the leaf. In addition, they work on the stems of cucumbers, and often completely girdle them. They also feed on the blossoms and the fruits. Besides the mechanical injury which they cause, they carry bacterial wilt of cucurbits. The bacillus which causes this disease lives over the winter in the alimentary tract of these beetles. In the spring, they inoculate the young plants with this disease and spread it from one plant to the next as they feed. They also spread the mosaic disease of cucumbers, and while in the larval stage they tunnel in the roots and underground stems. Cucumbers, cantaloupes, watermelons, and pumpkins are injured the most, but they also work on other vegetables to some extent.

The cucumber beetles may be controlled with barium fluosilicate,

mixing it with talc at the rate of one part of barium fluosilicate to 2 parts of talc. The mixture should be dusted lightly on the plants after the dew is off and when the beetles appear in damaging numbers. Applications of dusts on hill crops can be made to advantage with a bellows duster equipped with a funnel nozzle (Fig. 48).

In gardens, young plants may be protected by covering with screen wire cones or by shallow screen-covered wooden boxes. Bordeaux mixture is frequently used as a repellent.

CABBAGE LOOPER (*Autographa brassicae*). The cabbage looper is a serious pest not only of such cruciferous crops as cabbage and kale, but also of lettuce and sometimes of beets and peas. The adult is a moth whose fore wings are dark brown, variegated with lighter brown. Near the center of each wing are two joined silvery spots, one of which is oval and the other is U-shaped. The pale green to yellowish eggs are deposited on the leaves of the host. The young larvae are pale green and feed at first on the outer leaves of the cabbage. The full-grown larva is $1\frac{1}{2}$ inches in length, green in color, with a white lateral and two white dorsal stripes extending the length of the body. They crawl in a looping motion, hence their common name. The larva spins a flimsy white cocoon which is attached to the leaves.

This insect may be controlled with arsenate of lead at the rate of 2 pounds to 50 gallons of water; but it is not safe to use this material on kale and lettuce, or on cabbage after heads begin to develop. It can be controlled also with a rotenone compound applied at the same dilution as is used for the corn ear worm, and this is much safer than arsenicals.

ONION THRIPS (*Thrips tabaci*). The onion thrips is a serious pest of onions and it also attacks melons and cucumbers. These insects are yellow in color and only about $\frac{1}{25}$ of an inch in length. They have narrow fringed wings and run and fly very swiftly.

The eggs are inserted in the tissue of the plants where the young nymph feeds. In feeding, the thrips puncture the tissue of the plant and suck out the juice, causing the leaf to turn white. When the infestation is severe, the leaves assume a bleached appearance. Their damage is most severe when there is a lack of moisture. These insects are difficult to control, the best results being obtained by spraying with nicotine sulfate, at the rate of one pint to 100 gallons of water, to which 4 pounds of soap is added. A special type of nozzle is necessary to force the material into the sheaths of the leaves. If the spraying is not done before the infestation becomes severe, it is difficult to obtain effective control.

WHITE GRUBS. The larvae commonly known as white grubs are the larval stages of a great number of species of brown beetles. The adults are most abundant in early spring. They hide underneath rubbish and leaves during the day time. At dusk, they leave their hiding places and begin to feed on the leaves of trees. Some wingless species feed entirely on low-growing vegetation and they are especially injurious to vegetables. The eggs are deposited in balls made of soil about 2 inches below the surface of the soil. The larvae, which are commonly known as grubs, are white in color with brown heads and six prominent legs. They usually lie in a curled position. In some species, the larval stage lasts only one year, but more often it extends over a period of 3 years. During this entire time, the larvae continue to feed on the roots of plants, and, when they are abundant, the plant gradually turns yellow and finally dies. The eggs are usually deposited in sod or in soil that has been covered with grasses. For that reason, vegetables should not be planted on such land until row crops have been grown on it for 2 or 3 years. When the adults are not too abundant, they can be controlled with arsenate of lead at the rate of 2 pounds to 50 gallons of water.

Other insect pests which attack different vegetable crops and their control methods are discussed in the special crop chapters.

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STORING VEGETABLES

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Storage of vegetables in the South for future shipment in carlots is relatively unimportant except in the case of sweet potatoes. This is because the value of truck crops grown in the South usually depends upon earliness. Stored vegetables would merely compete with fresh ones from other regions nearer the larger markets, and for this reason, storage of vegetables for shipment is not economical because of the reduced value as well as the cost of storage.

From the standpoint of local markets and the individual farm homes, storage is very important. As a rule, the shipping season for individual truck crops does not last long, but the demand for the product may continue. The price may be relatively low during shipping periods, but it will likely increase as the supply decreases. Storage is important in order to prolong the season of certain vegetables and to maintain prices at levels that will be beneficial to both producer and consumer. Too often in the South, the farm vegetable garden is limited to a short period in the spring, and if storage of certain crops will help insure year-round vegetables for the farm home, the cost of living will be reduced and the health of the farm family improved. Storage, then, is of considerable importance in the South even though, in many sections, year-round gardens are possible. Information concerning storage is important in order to keep the stored product in the best possible condition.

Vegetable products must be in good condition to be stored successfully. Usually it is desirable for stored vegetables to be as nearly like freshly harvested ones as possible. Information concerning changes that are likely to take place in storage is important. All vegetables stored at temperatures above their freezing point are alive and life activities continue, though they may be slowed down by storage conditions. During the storage period a certain amount of physiological shrinkage takes place. This is caused largely by loss of moisture, but is due also to loss of solids used up in the process of respiration. Sometimes loss of moisture increases the dry matter content of the stored product, as often occurs with sweet potatoes during the curing period. The

change in moisture content is not nearly so great as the gross shrinkage, shown by loss in weight, indicates. For example, cucumbers which had a moisture content of 95 per cent when harvested were kept at a room temperature of 70° to 80° F. for 2 weeks, and, though the shrinkage in weight was 7 to 8 per cent, the moisture content increased from 95 to 96 per cent. This is an unusual case, but it emphasizes what may take place in physiological shrinkage. Watermelons kept at room temperatures behave somewhat similarly. The importance of physiological shrinkage is often underrated by those storing vegetables. As far as food value is concerned, there may be little or no loss in many stored products. In some cases, as with the sweet potato, storage may be an actual advantage in food value as well as in quality.

Loss from rot or decay is entirely different from physiological shrinkage, and it is often much more serious from an economic standpoint. Physiological shrinkage exacts a more or less definite toll, depending on the condition of the product and storage conditions, while losses from rot may vary from nothing to 100 per cent. It is the object of proper storage to reduce both types of shrinkage to a minimum while maintaining the quality of the product stored.

Storage Requirements

TEMPERATURE. One of the most important factors to be considered in connection with storage is temperature. In general, life activities in vegetables increase with rise of temperature from the freezing point to the maximum temperatures ordinarily encountered. For most vegetables, loss from decay organisms is lessened as the temperature is lowered, with a few exceptions, including sweet potatoes and pumpkins. This means that the storage temperature should be kept low for most material without allowing it to freeze. Most vegetables freeze at temperatures varying from 28° to 30° F. If only one storage room is available and the temperature may be controlled, the best temperature for general home storage of vegetables is probably between 36° and 40° F. Many vegetables, however, prefer a lower and some a higher temperature (Table 17).

The response of Irish potatoes to cold storage temperatures is different from that of most vegetables. With a drop in temperature from 40° to 32° F., the respiration rate does not decrease, but may even increase. Below 40° F., sugars accumulate in appreciable amounts in Irish potatoes and the starch content is reduced. If much sugar is present in potatoes, their cooking quality is greatly impaired. If potatoes from cold storage

Table 17. Commercial Storage Requirements and Approximate Maximum Storage Period for Vegetables

Vegetable	Temperature, Degrees F.	Relative Humidity, Per Cent	Maximum Storage Period [1]
Asparagus	32	95–98	1 week
Bean, snap	40	90–98	12 days
Bean, lima	32	90–95	2–3 weeks
Beet	32–40	90–95	4–5 months
Broccoli, sprouting	32	95–98	10 days
Brussels sprout	32	95–98	2 months
Cabbage	32–40	90–98	5 months
Carrot	32–40	90–95	6 months
Cauliflower	32	90–98	30–40 days
Celery	32	90–98	3–5 months
Cucumber	32–40	95–98	4–5 weeks
Eggplant	32	90–95	3–4 weeks
Kale	32	95–98	1 month
Lettuce	32	95–98	3–4 weeks
Muskmelon, immature	50	80–90	2 weeks
Muskmelon, mature	32	80–90	1 month
Onion and onion sets	31–32	80–95	5 months
Parsnip	32	90–95	5 months
Pea, green	32	95–98	2 weeks
Pepper	32	95–98	40 days
Pumpkin	40	50–70	2–3 months
Rutabaga	32–40	90–95	3–4 months
Squash	40	50–70	5 months
Sweet corn	32	90–98	3–4 weeks
Tomatoes, green ripe	50–60	95–98	1 month
Tomatoes, ripe	40	95–98	10 days

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[1] The length of time during which vegetables may be kept in cold storage depends on differences in growing conditions, state of maturity, the variety of the vegetable, disease infection, and other factors.

which are sweet, because of high sugar content, are kept for about 2 weeks at room temperatures, the sugars will largely revert to starch. When potatoes are removed from cold storage to higher temperatures, the respiration rate is higher for a period of a few days than is normal for that temperature. The lower the storage temperature and the higher the temperature after removal, the greater the abnormal respiration rate. This means that potatoes removed from storage at low temperatures should receive special care as to ventilation for a few days at least.

Sweet potatoes are the most important stored crop in the South, and they should be kept at temperatures from 80° to 85° F. for about 2 weeks

after digging. During this so-called curing period, wounds of the sweet potato heal, the most rapid loss of moisture for the storage period takes place, and the sugar content, especially sucrose, increases. Artificial heat is usually necessary to maintain sufficiently high temperatures for curing, but, in the far South, this has been found unnecessary if potatoes are dug during dry, warm weather. What is meant by a cured potato is very indefinite, as there is no reliable test for this condition. During the storage period of sweet potatoes (after curing), the temperature is kept as near 50° to 55° F. as possible. This is accomplished partly by regulating ventilators, which may be closed most of the time during cool weather, unless it is necessary to build a fire in the house. Sweet potatoes become more susceptible to injury from certain rot organisms at temperatures much below 50° F. Low temperatures seem to reduce the resistance of the roots to the decay organisms. Sweet potatoes will stand low temperatures, above the freezing point, for short periods of time without serious injury, but exposure to low temperature for extended periods is sure to result in injury. Pumpkins and winter squash require storage conditions somewhat similar to those for sweet potatoes, except that no curing period is necessary.

MOISTURE. Humidity of the storage place is a very important factor, since the relative humidity has an important bearing on moisture loss. In general, the higher the humidity of storage, the lower the water loss, and this is beneficial with many vegetable products. High humidity, however, tends to increase growth of molds and other decay organisms, and for this reason may be very harmful. Moisture should not be allowed to accumulate on the walls, containers, or on the stored product. Onions, sweet potatoes, and pumpkins require a dry atmosphere, 60 to 75 per cent of saturation, while the ordinary root crops and celery keep best under high humidity. The humidity of storage rooms may be controlled to some extent by regulating ventilation and temperature.

AERATION. Oxygen in fresh air is necessary for respiration in the stored material, the higher the respiration rate the greater the need of fresh air. The respiration rate of Irish potatoes is high for a few days immediately after digging, so proper aeration is especially important at that time. Black heart, a breakdown of center tissue in Irish potatoes, is caused by suffocation, a lack of oxygen. This occurs in Irish potatoes kept at temperatures as low as 32° F. when insufficient fresh air is present.

When placing vegetables in storage, the containers should be so arranged that there is free access of air to all the stored material. A

ventilated false floor should be used where most produce is stored. As previously stated, ventilation is also important in helping control the humidity of the storage atmosphere.

LIGHT. Direct sunlight is generally injurious to stored material, but is not often an important factor. Most vegetables should be stored in the dark or at least in very reduced light; but some light does not seem to be injurious to sweet potatoes, pumpkins, or shallots.

CONDITION OF CROP. The necessity for the material to be stored to be in good condition cannot be overemphasized. The physical condition of stored vegetables does not improve in storage, but usually depreciates to some extent in spite of the best of care. This means that only the best products possible should be stored. They should be handled very carefully and bruises or other mechanical injuries reduced to the minimum. No decay or rot should be present, as this is likely to be injurious to the healthy vegetables as well as to those that are infected. Sweet potatoes that are to be stored should be dug before the vines are killed by frost, if successful storage is expected. Before spring- or summer-dug Irish potatoes are placed in cold storage, they should be kept for 10 to 14 days at normal temperatures. The reason for this is that wounds will heal and the skins suberize much more readily at the higher temperatures when the relative humidity is high than they will at cold-storage temperatures. Another advantage of waiting is that the most rapid shrinkage occurs during the first few days and the amount of material on which storage will have to be paid will be reduced.

If Irish potatoes have been exposed to enough sun at digging time to cause injury, there is no use to attempt to store them. It is unwise to take a chance on storing vegetables the condition of which is questionable.

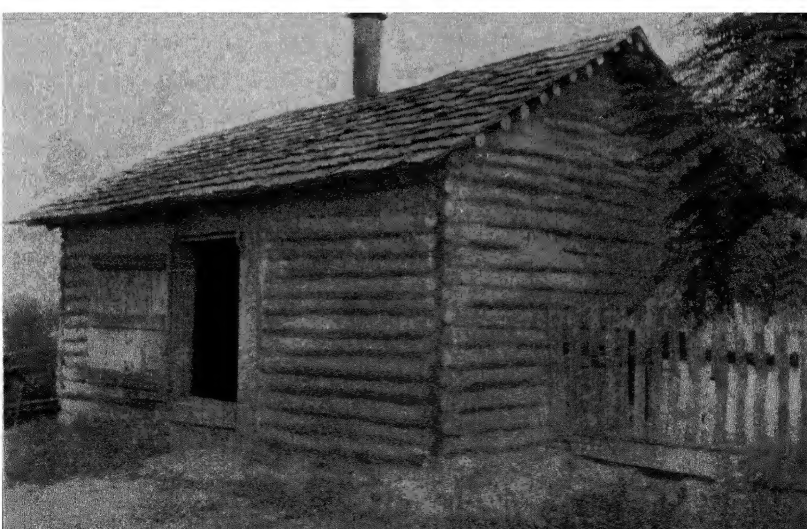
SANITATION. Sanitation is good storage insurance, and it is very unwise to store excellent material in places overrun with sources of rot infection. Good storage conditions do not often entirely prevent rot, but help to keep it at a minimum. This means that the storage room should be kept as clean as possible, and a thorough disinfection should be given from time to time when the storage house is empty.

PROTECTION FROM RODENTS. Storage houses should be constructed as nearly rat-proof as possible. If rodents enter the house by coming from the field in storage containers or otherwise, they should be killed the easiest available way. Rats and mice not only destroy or render considerable produce unmarketable, but they also increase the

loss from decay, since decay organisms find ready entrance to stored vegetables that have been gnawed by these rodents.

Storage Methods and Structures

STORAGE HOUSES AND SHEDS. A sweet potato house is essential when the crop is grown and stored for sale or for farm use. A sweet potato storage house should have a good roof and should be as well insulated as possible. This means double walls, floors, doors and windows, and a ceiling. Floor and ceiling ventilators are necessary, and should be arranged so they can be easily opened and closed. Plans for building sweet potato houses may be obtained from the United States Department of Agriculture, and the extension services or experiment stations of the various states. It is not necessary to build a new storage house in many cases, as another farm building may be converted into a satisfactory sweet potato house. Small amounts of sweet potatoes may be kept in unused rooms if given proper ventilation and protection from cold. In some parts of the South, log sweet potato storage houses have been built at low cost and operated successfully (Fig. 51). A storage



A J Lafferty, Hope, Ark.

FIG. 51. An inexpensive sweet potato curing and general purpose farm storage house constructed of poles and mud.

house may be used to keep fall-grown Irish potatoes during the winter, but the temperature for this crop should be kept lower than for sweet potatoes.

An ordinary storage shed is very useful and does not need to be as well constructed as a sweet potato house. The main essentials of a storage shed are: (1) A roof that does not leak, (2) protection from direct sunshine, (3) provision for ample ventilation, and (4) a cool location. An ordinary sweet potato house cannot be given sufficient ventilation to be used satisfactorily for a place in which to cure and store onions for a time after digging. A storage shed can be used for the storage of onions and Irish potatoes. Creole onions will keep in such a structure all summer. Irish potatoes may be kept in a storage shed for about three months or until the rest period is over, after which they may sprout badly.

STORING IN PITS, STORM CELLARS, AND DUGOUTS. Where drainage permits, storage pits or dugouts built in small ridges or hills are used to some extent for storing some types of vegetables. Special attention should be given to ventilation, for, at best, these types of storage will usually have high humidities. Root crops may be successfully stored in them and Irish potatoes may be kept with fair success.

STORING IN THE FIELD. Field storage is practiced to a slight extent in the South. Root crops are often allowed to stay in the row after they are mature and are harvested when desired, over a rather extended period. For example, in some sections of the South, fall Irish potatoes are permitted to remain in the ground until winter.

STORAGE IN BANKS (MOUNDS). The bank type of storage is best adapted to root crops. It has been used most extensively for storing sweet potatoes in the cotton belt, but this type of storage is not recommended for this product. Occasionally, it is used with fair success, but the odds against it are too great.

In providing this type of storage, a well-drained place must be selected for the mound. Straw or pine straw should be put on the ground first. A ventilator may be made by nailing three boards loosely together, forming a triangular flue. This is set upright in the middle of the pile, and the vegetables are placed around the ventilator. A layer of straw about 6 inches deep should be put over the piles of vegetables and this covered with approximately a 6-inch layer of soil, more being used in localities where winters are severe. The ventilator should be kept open

except in extremely cold weather. It is better to make several small banks than a large one, for when a bank is once opened, the part not removed is likely to spoil. The material stored in banks is not easily accessible, especially in wet weather. Although bank storage is not generally recommended, it has the advantage of being cheap, and, consequently, is available to all.

COLD STORAGE. In this type of storage, produce is stored at fairly well-controlled low temperatures, and, in some storage houses, the humidity also is controlled. With a few exceptions, this is the ideal type of storage, expecially in the South, where even in the winter great fluctuations in temperature and humidity cause considerable variation in most other types of storage. The disadvantages of this type of storage are high cost and distance from the farm. However, as advances in refrigeration are made, it is not impossible to imagine the better farmers of the future having cold-storage units of their own or renting room in cold-storage plants. The market gardener may now extend the duration of crop seasons by use of cold storage. Although information concerning cold storage of vegetables is limited, it is known that most vegetables will keep for a time in cold storage, and that many are easily kept. Cucumbers, however, will soon shrivel badly if kept under ordinary cold-storage conditions. Most vegetables are kept in cold storage with temperatures ranging from 32° to 40° F. as shown in Table 17. Onions will keep best if stored in a dry atmosphere at a temperature of about 32° F. For root crops and cabbage, 33° to 35° F. is probably low enough, as too low temperatures may be injurious. Sometimes the temperature, even in controlled cold-storage rooms, will vary, and if produce is being kept at 32° F., and if the temperature goes lower, there may be injury. Irish potatoes, sweet potatoes, pumpkin, squash, and tomatoes require higher temperatures.

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13

MARKETING SOUTHERN VEGETABLES

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Marketing Evolution

EARLY CONDITIONS. Until relatively recent times, the South had no large cities except New Orleans. Nearly all the important towns were either seaports or river ports dependent upon water-borne commerce for most of their business and prosperity. Early railroads, built from these ports into the interior, were designed to carry finished goods inland and to bring cotton, lumber, naval stores, tobacco, grain, and coal to shipside for export or for coastwise traffic. Commercial refrigeration was not introduced until 1886, and it was years later that merchant vessels were equipped to carry even their own supplies at low temperatures.

Necessarily all vegetable production was for local sale and use. Vessels leaving port could carry more than a few days' supply of sweet potatoes, but this was true of almost no other locally grown vegetables. Thus early vegetable production in the South was confined to the immediate vicinity of the ports. New Orleans, the largest city and most important port, had the largest nearby population largely dependent on vegetable gardening. The descendants of the Acadians are the oldest group of commercial gardeners in the South.

THE DAWN OF A SHIPPING BUSINESS. The first shipments to northern markets were from Chesapeake Bay and South Atlantic Coast towns by steamer. These were of winter or very early spring vegetables, especially cabbage and various greens, which went north while the weather was still cool. Natural ice, shipped down from Maine to southern ports, was used in part for crushing and mixing in the barrels with these green vegetables. This was the first crude form of refrigeration. Such business was confined to the seaboard.

ARTIFICIAL ICE. This and the specially constructed refrigerator car introduced the period of tremendous truck crop expansion in the South. The first car of southern products under refrigeration crossed the Potomac River in 1887. Since that date an enormous industry has

come into being. It involves a business of a billion dollars per year, and the movement throughout the year, and from all parts of the continent, of vegetables so perishable that without refrigeration they would seldom have been seen more than a hundred miles from where they grew. As long as refrigerated shipments were dependent on natural ice, a great southern vegetable industry remained an impossibility.

NEW PRODUCTION AREAS. With an iceplant in every railroad town, all suitable land adjacent to any railroad became available for truck crop production. Certain coastal areas lost their pre-eminence to certain inland areas. The spinach acreage in South Carolina, concentrated around Charleston and Beaufort, shrank from an early maximum of perhaps 7,000 acres to a recent low of only about 700 acres, while Texas shipments rose by leaps and bounds.

The extent to which vegetable production could be increased in the South is well-nigh incalculable. Certainly during the lives of those who will read this book while it is still new, the supply of southern truck crops will be limited only by the capacity of the market to take these crops at prices which will give the growers a modest living (Fig. 52).

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FIG. 52. Southern vegetables for sale on the New York piers.

GROWING DEMAND. Improved transportation with refrigeration found the northern industrial centers growing rapidly and with a large and ever-growing need for fresh foods which could not be met by local supplies. The southern industry sprang into existence in response to a very definite and active demand. Northern capital flowed south to stimulate and largely to control the industry.

As increasing thousands worked at desks in stores or attended to machines which did the heavy work in industry, food habits underwent a notable change. They ate relatively less bread and meat and relatively more fruits and vegetables, both fresh and canned. Many authorities on health believe that there should be a still further increase in fresh vegetable consumption. All of this suggests that southern truck crops are likely to grow, rather than to decline, in importance.

COMPETITION IN THE MODERN MARKET. The same efficient refrigeration in transit which has made our southern industry possible has also brought every perishable luxury of the Pacific Coast into the eastern markets. There is now the competition incident to wide choice. If one vegetable is scarce or high, the housewife can easily use something else. No section is likely ever again to monopolize the supply of greenstuffs.

Competition takes another form, also incident to modern transportation. The refrigerator car is so thoroughly insulated that, without ice, it brings perishables from the frost-proof storages near the Canadian border to every market of the land with but little loss from freezing. Southern vegetables meet this competition even in the cities on the Gulf Coast. The French gardener of Louisiana no longer has his New Orleans market to himself. He finds there, potatoes from Maine and from Idaho, onions from both the Rocky Mountain and the Great Lakes states, apples from the Allegheny Mountains and from the Pacific Northwest. Truly competition in perishables is both nation-wide and all-embracing.

ROADS AND MOTORS. One of the latest developments in the evolution of this industry is the movement of very large quantities over relatively long distances by motor truck. Modern hard-surfaced roads have made this possible. The invention of the gasoline engine and the automobile created the demand for the roads and made it possible to raise the money for their building and maintenance. The road and the motor are economically inseparable. Their effect on vegetable industries is already profound and their story is probably as yet only half told.

Movements of fruits and vegetables by trucks have increased tremendously in recent years (Table 18).

TABLE 18. TRUCK *vs.* RAIL MOVEMENT OF FRUITS AND VEGETABLES [1]

AREA	1933		1934	
	Total carlots	Per cent moved by truck	Total carlots	Per cent moved by truck
New England States .	89,839	40	91,907	43
Mid. Atlantic States .	238,384	64	251,613	66
E. No. Central States	98,981	60	106,538	60
W. No. Central States	66,610	30	47,870	33
E. So. Central States .	88,240	30	100,062	31
Florida	121,916	15	124,256	18
W. So. Central States	69,981	30	87,104	28
Mountain States . .	82,762	18	89,439	18
Washington-Oregon .	67,664	17	80,802	17
California	323,667	30	349,585	31

[1] From *Shipment of Fruits and Vegetables from Producing Regions to Consuming Markets by Motor Truck, 1933 and 1934*, Div. of Fruits and Vegetables, B. A. E., U. S. Dept. Agr., Mimeograph Bulletin, released October, 1935.

Perhaps no one can yet list the effects of the use of motor vehicles on this industry in the order of their importance, but the following results can be noted:

(1) They speed up all deliveries within approximately 150 miles.

(2) They haul less than carload quantities and thus supply the small towns with about the same choice of products and at about the same prices prevailing in carlot markets.

(3) They deliver goods to the stores instead of the railroad yards and docks.

(4) This inevitably increases the total consumption.

(5) Men with insufficient capital to engage in carlot merchandising can become merchant-truckers. This intensifies competition.

(6) The truckman operates successively in several districts; he has little opportunity to establish his credit. He is usually a cash buyer and a prompt seller. This tends to narrow the margins and to make the way hard for operators of the older type.

(7) And now comes the refrigerator truck, lengthening the possible haul and further improving the quality of the delivered product.

FURTHER EXPANSION OF AREA. When growers were dependent on rail transportation and products were hauled to the cars in farm

wagons over rough roads, no land could be used profitably for vegetable growing unless it was within a few miles of a town or a railway station. Today our road system has been so improved and motor vehicles are so generally used that almost all southern land which is adapted to vegetable growing could be so used. Location is now seldom a controlling consideration. This has brought the cheaper lands into competition with the higher priced lands of the older producing districts.

EVOLUTION IN CITY DISTRIBUTION. In many towns the old farmers' markets remain and are well patronized. They tend, however, to become jobbing rather than strictly retail markets. Trucks have replaced the farmers' wagons and many of these come long distances.

The grocer of today is better prepared to handle perishables than was his predecessor. Delivery to and from his store has been quickened. Cash-and-carry chain stores now tend to feature fresh vegetables. Consumption per capita has obviously increased greatly within the last twenty years. How long this can continue no one knows, but since we have almost reached the point of stationary population, with the birth rate very little higher than the death rate, it would seem that the total volume of demand for vegetables must have very nearly reached its limit.

The increasing thousands who live in apartments have little space for storage and necessarily buy daily, for daily needs. There must be a large assortment conveniently near-by and obtainable in small quantities. This implies many retail stores. In the larger towns direct contact between producer and consumer is almost impossible. The hardiest of housewives would hardly attempt to board a New York subway or elevated train with a market basket. The density of population compels the family to buy its food within a few blocks of home.

These conditions also make difficult the disposal of waste or garbage. The cook wants her vegetables clean and as nearly ready for the pot as possible; hence the demand for washed potatoes in consumer packages. Only in recent years has the South begun to wash early potatoes for carload shipment. This is but one instance of the changes in marketing practice at the shipping point which have been induced by changes in the surroundings of consumers and the resulting changes in distribution.

ROADSIDE MARKETS. Except for a limited number of favorable locations, roadside markets are practicable only when they can be attended by some member of the family not otherwise employed.

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FIG. 53. A roadside market should be attractive, well placed, and prominently marked.

Experience almost everywhere proves that it is the stand with a large display which attracts the business. Therefore, a roadside stand which yields most of the farmer's income must be on a heavily traveled road and within less than an hour's drive of a city of some size if vegetable sales are to be largely depended upon.

Unless the business in sight justifies a substantial roadside structure, the business is necessarily limited to good weather. Fresh supplies cannot be gathered in the mud to replace sales made hour by hour, as is almost necessary with highly perishable products.

It usually pays to have an attractive, conveniently arranged market built to accommodate the needs (Fig. 53). It should be prominently exposed and well marked.

When studied impartially, it will be seen that the roadside stand devoted chiefly to vegetables is likely to be disappointing. It cannot offer the variety and quality to be found in a large city market unless it has a large city patronage. In relatively few southern locations can this be obtained.

Vegetables may, however, make a worthwhile contribution to a general farm stand, offering fruits, eggs, honey, and other farm products. Those vegetables which are most nearly like fruits, such as cantaloupes and tomatoes, are likely to prove most popular with the roadside buyer.

The general experience is believed to be that fruits and berries furnish the income while vegetables merely serve as incidentals to swell the totals.

Processing and Marketing

PREPARING FOR MARKET. Methods of handling and preparation of vegetables for shipment have undergone rapid changes in recent years. Culls will seldom sell for enough money in northern markets to pay for packing and transportation. Ten or 15 per cent of culls in a package may cause it to sell for so little that it will return the grower less than the cost of production. It is usually a great mistake to try to make the good sell the poor.

GRADING. Grading or the sorting of vegetables so that the contents of each package will be fairly uniform, is usually a paying operation. Even products of second quality will present a better appearance when packed by themselves, with no first-class products in the same package. Uniformity appeals to the eye and suggests that the vegetables have been carefully handled.

The United States Department of Agriculture has recommended uniform grades for each important vegetable. Several states have written these grades into their laws and some have made their use compulsory. Congress has thus far made no such requirements.

The writer has always believed that the grower should do as much grading as he finds profitable and no more. Grading requires the investment of more time and money in the products, after they are harvested, in the effort to make them more salable. This is usually a profitable investment, but if it is not found to be profitable it should not be required.

Broadly speaking, the further the grower is from his market or the greater his marketing costs, the more carefully he must grade and the less likely it is that he can sell his culls at all. The nearer he is to market and the smaller his marketing costs, the better his chances to sell low grades for something more than the cost of handling.

Southern vegetables are often in competition with those from the Pacific Coast which must be closely graded to bear the high cost of marketing. Competition compels the southern grower to grade carefully so much of his produce as can be made to meet the requirements of U. S. No. 1 grades, if he is to derive all the advantages of his lower marketing costs.

State laws designed to force such grading assume that the lawmakers know better than the grower how he should conduct his business. Some of these laws make it an offense to sell vegetables exactly as they come from the field.

Since the only reason for grading is to increase the value of the prod-

ucts, it seems logical that the method of grading should be left to the judgment and experience of the industry.

PACKING AND PROCESSING. The competition incident to a chronic state of overproduction, or in other words a persistent buyers' market, has resulted in recent years in the bad habit of overfilling boxes, crates, and baskets used for shipping many southern vegetables. The bushel basket of spinach from almost any district, or of bunched vegetables or root crops, is so overfilled that some physical injury is sure to occur and such damage is often serious. Yet the buyer demands it.

The retailer must sell spinach and cabbage by the pound. He reasons that it is to his advantage to get a heavy pack even if some of it is crushed. Receivers in New York sometimes loosen the cover of a neatly packed bushel of spinach and pull out some of the plants until they hang down the sides, giving the impression that the baskets have been filled with more than the cover could hold down.

Such practices tend to destroy the advantages of standard containers. A bushel of spinach is no longer a specific number of cubic inches, but it is as much as the cover of the basket can be sprung over, often nearly five pecks by honest measure. But should a scarcity develop, the height of the bulge may shrink rapidly. A cafeteria manager in Washington reported that the actual outturn of spinach varies by as much as 10 pounds per bushel basket, ranging from 18 to 28 pounds net.

All standard containers hold their prescribed amounts when filled level full. They are tested by struck measure. Covers of bushel baskets are made with a rim which allows for a slight crown or overfill when the rim of the cover rests on the basket. To fill the basket so that the rim of the cover is held above the basket rather than on it, is to insure varying degrees of injury when the baskets are stacked in a car and are jostled over hundreds of miles of railroad.

Boxes and crates which are covered by wooden strips or by sheets of veneer are always packed with a bulge. The top is sprung down over a pack which is crowned or bulged noticeably above the sides. This is sometimes so excessive that tomatoes or other small vegetables can be slipped out between the lid and the side of the package without drawing a nail.

This whole deplorable situation could be corrected by co-ordinated action among the growers or by the railroads. If the roads should attempt it without the support of the shippers, however, they would promptly lose more business to the trucks.

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FIG. 54. Crated vegetables with chunk top icing.

Processing vegetables usually means canning and preserving, but certain modern practices in handling fresh products may be so defined. Among these are the precooling of both cars and products to remove field heat before they begin their journey and, more recently, the washing of potatoes and celery before loading for shipment.

Precooling saves some icing in transit. Often a precooled carload can go through to market under initial ice without stopping to be re-iced as would otherwise be necessary, thus speeding up delivery.

Top-icing, with chunk or crushed ice which is blown over the entire load between the top layer and the roof of the car, is another development which helps to bring southern vegetables to northern markets with almost their natural freshness (Fig. 54).

Table E in the Appendix gives the description and the approximate number of containers necessary for loading cars of different kinds of vegetables.

CARELESS HARVESTING. The limiting factor in the successful marketing of much southern produce seems to be the rough handling to which it is subjected before it is delivered to the carriers. Relatively

few southern growers seem to realize how serious this is with such a staple vegetable as the sweet potato, which has often received its death blow before it leaves the farm. Adding watermelons and strawberries, we have a triangle which may be said to touch the extremes of the industry. Each suffers in its own way at the hands of the careless grower and takes its revenge to the tune of so many thousands of dollars lost to growers and shippers that the figures, if accurately obtainable, would be staggering.

CO-OPERATION IN MARKETING. Co-operation is desirable among the members of a group having a common interest as far as that interest can be served by joint action. Organizers have not always observed these limits, and many failures have resulted. Effective co-operation among vegetable producers is especially difficult because so many growers are tenants or others who may go into or out of vegetable growing from year to year. In other words, vegetable growers usually lack that continued common interest throughout a large group which is characteristic of fruit growers, all of whom have similar long-time investments which cannot be changed.

Southern vegetable growers are not safe in building packing houses, potato-washing plants, and similar equipment with the aid of borrowed capital. The continued interest of the organizing group cannot be depended upon. A few bad seasons may cause many operators to quit the district. With them will go the outside capital which has been loaned to growers to produce the crops. Few southern districts are prepared to continue vegetable production on a commercial scale without loans or advances from distributors. This is an unhealthy situation for which many are now seeking remedies.

Co-operation in obtaining credit seems highly desirable, but the tenant is an unstable member of a credit union, and without the tenants, in most districts, there can be no effective control nor wise planning of co-operative endeavor.

The national agencies controlled by co-operative organizations are of necessity little more than immense brokerage houses. They distribute carlots to carlot buyers, auctions, or jobbers, and sometimes merely consign them to commission men. They own no stores or jobbing houses in the markets. This is perhaps wise since the opening of such houses would make them competitors of their carlot customers.

The chief service which they render the grower seems to result from their wide acquaintance with buyers and their constant keeping in touch

with all markets. They are evidently in a better bargaining position than any individual shipper. They can make collections and invoke promptly and effectively the available agencies of Government to protect the growers' interests.

The desirable program for southern vegetable growers would seem to involve united action in the purchase of supplies for cash with money borrowed, when necessary, from federally controlled financing agencies; co-operative grading, packing, and carloading; with dependence upon a grower-controlled marketing agency for nationwide distribution.

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INTRODUCTION TO SECTION II

PRACTICES

INTRODUCTION TO SECTION II

Section II, containing Chapters 14 to 33, deals with specific production practices followed in growing different vegetable crops. Each chapter contains mainly practical information, prepared by an outstanding southern horticulturist who has a special knowledge and interest in that particular crop.

In discussing the culture of different crops, it is assumed that the reader is familiar with the principles underlying the various operations as discussed in the first 13 chapters. An understanding of these principles will be a considerable aid in applications to the different jobs.

In view of the fact that the botanical and horticultural relationships of the various vegetables were fully discussed in Chapter 2 on Classification of Vegetables, the arrangement of the crop production chapters is alphabetical by crops, rather than by botanical relationships. This arrangement provides for convenient reference, and should not discourage the student from studying or comparing related vegetables.

Each chapter is complete in itself, but references are made to similar discussions elsewhere in order to supplement information or to conserve space. Pertinent facts on the crop under discussion, including botanical classification, history, production scope, economic importance, and climatic requirements, are systematically given at the beginning of the chapter.

The subject matter of the vegetable chapters is treated according to the job-analysis plan. Each vegetable enterprise is divided into jobs or teaching units, covering the subject in order of seasonal sequence. The jobs are further sub-divided into special operations.

A typical outline showing the job-analysis treatment used in the chapter of each vegetable enterprise is given below:

Job 1. Selecting Varieties and Seed

Determining a Variety
Securing Seed

Job 2. Preparing the Soil

Soil Preference
Preparing the Seed Bed

Job 3. Fertilizing, Manuring, and Liming

Fertilizing
Manuring
Liming

Job 4. Planting and Protecting

Starting Plants under Protection
Seeding in the Field

Job 5. Cultivating and Irrigating

Cultivating
Irrigating
Thinning and Weeding
Training

Job 6. Controlling Diseases and Insects

Controlling Diseases
Controlling Insects

Job 7. Harvesting, Processing, and Marketing

Harvesting
Grading
Packing
Storing
Marketing

The statistics on each crop, including acreage, acre yield, production, unit price, farm value, carlot shipments by important southern and other leading states, have not appeared in similar form elsewhere. The student will find many interesting comparisons in these tables, which were prepared from reports supplied by the Crop Reporting Board, Bureau of Agricultural Economics, United States Department of Agriculture. The 7-year average embracing the 1929–1935 period tends to smooth out irregularities caused by the low-price 1931–1934 period.

Another feature contained in each crop chapter is the parallel description of the outstanding characteristics of the principal varieties. These

were prepared for general application, and were checked and approved by several authorities and seed companies.

Diseases and insects have been discussed somewhat in detail, because they are of great economic importance; and because their control is closely associated with production, and, in many cases, with transportation and marketing.

For completeness and convenient reference, scientific names of all plants, diseases, and insects appear in parentheses following the common name.

14

ASPARAGUS

R. A. McGinty, Clemson Agricultural College, South Carolina, Contributor

CLASSIFICATION, ORIGIN, AND HISTORY. Asparagus (*Asparagus officinalis*) is a member of the lily family and is indigenous to parts of Russia, the Mediterranean region, and the British Isles. It was used for food by the Romans and other ancient peoples, and was also highly regarded for medicinal purposes. The plant was brought to America by the early colonists.

SCOPE AND IMPORTANCE. Asparagus is one of the most desirable of early spring vegetables and is produced as a home garden and market garden crop throughout most of the United States. It does not thrive close to the coast in South Atlantic and Gulf states, but grows satisfactorily elsewhere in the South.

TABLE 19. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF ASPARAGUS (MARKET) IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

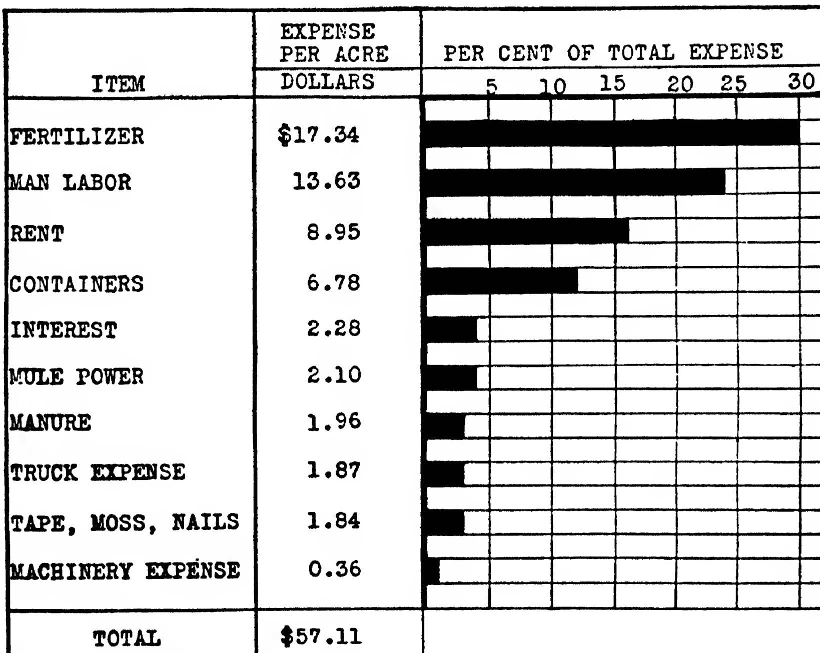
STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [1]	PRICE PER CRATE	FARM VALUE	CARLOT [2] SHIPMENTS	PRINCIPAL SHIPPING SEASON
Southern	Acres	Crates	1,000 crates	Dollars	1,000 dollars	Cars	By months
South Carolina	8,943	39	349	1.80	629	528	Apr., May
Georgia	3,957	24	93	1.86	173	112	Apr., May
Other States							
California	22,567	90	2,041	1.72	3,516	2,226	Mar.–May
New Jersey	9,286	98	914	1.64	1,502	18	May, June
Illinois	4,249	50	214	1.74	372	108	May, June
Total (average) for the 14 leading states	60,990	77	4,718	1.69	7,984	3,120	Mar.–June

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

The leading states in the growing of asparagus and the average acreage and production of this crop in each state during the 7-year period, 1929–1935, are shown in Table 19.

AVERAGE PRODUCTION COSTS. Cost figures covering asparagus production are reported by Russell and Fulmer of South Carolina (Fig. 55). Fertilizers and labor were the most important cost items in producing this vegetable. Production costs vary considerably according to season and location.



S. C. Exp. Sta. Bull. 301.

FIG. 55. Weighted average cost of producing asparagus, 1929, 1931, and 193-.

CLIMATIC REQUIREMENTS. Asparagus grows best where cool temperatures prevail during the growing season and where adequate moisture is available. The high summer temperatures occurring in the southern states do not favor maximum production of spears; but where there is sufficient cold in winter to render the plants dormant for a considerable period, profitable yields are possible if the crop is well fertilized and properly cultivated. Experiments at Baton Rouge, Louisiana, have indicated that worthwhile yields are not possible there, apparently because of failure of plants to store sufficient reserve food.

Job 1. Selecting Varieties and Seed

VARIETIES. The Mary Washington is the only variety grown to any extent in the South, and it is by far the most important in the whole country. The closely related variety, Martha Washington, is grown to some extent, particularly in the northeastern part of the United States. Both of these varieties are relatively rust resistant. The latter is somewhat more resistant than the Mary Washington, but it does not produce as desirable spears. In South Carolina, the full-grown stalks of Martha Washington have been reported to blow over badly during high winds.

In addition to the Washington varieties, there are a few others occasionally grown. Palmetto, which originated in South Carolina, is the most important of the old varieties, but Argenteuil and Reading Giant are still grown to some extent.

SECURING SEED. Some asparagus seed is saved in most of the areas where the crop is grown commercially. California, New Jersey, and South Carolina are the sources of considerable quantities of seed. Prices of seed vary from 50 cents to $5 per pound, depending upon its source. Seed saved in the fall from a planting which produces good quality asparagus is probably about as satisfactory as that from any other source.

Job 2. Growing and Selecting Crowns

Asparagus plants are grown in a nursery for one season, and then set in permanent fields. The grower may buy crowns or grow them at home. If home-grown crowns are used, production of a crop will be delayed one year; but the cost of establishing may be less and the grower will have more opportunity to practice crown selection.

In growing crowns in the South, the seed is usually planted on sandy loam soil in February, March, or April with the rows 24 to 30 inches apart. Garden seed drills or other planters provided with special plates are commonly used for planting. Preferably, seeds are dropped singly 2 or 3 inches apart and covered 1 to 1½ inches deep. About 5 pounds of seed are ordinarily used to plant an acre. Since the seed is slow to germinate, soaking for 3½ to 4 days in water kept at a temperature of 86° to 95° F. is sometimes practiced. The water should be changed each day during the treatment. If this is done, the seed should be planted immediately in moist soil, for if planted in dry soil, the benefits of soaking are lost. Probably little is to be gained in the South from soaking the seed unless planting has been considerably delayed, which

would make it desirable to hasten germination. A soil temperature of 68° F. will allow the seed to germinate slowly, but the optimum temperature is 77° to 86° F.

In growing crowns on a large scale the seed is usually planted at the rate of 4 or 5 pounds per acre. This quantity of seed will, according to nurserymen, produce about 30,000 or more plants.

Ordinarily the soil used for growing asparagus crowns should be fertilized at planting time with about 800 to 1,000 pounds per acre of a 4-8-4 or similar fertilizer. The plants are cultivated during the season as any other row crop. It is preferable to dig the crowns shortly before planting in the spring, and the digging should be done in such manner as to injure the storage roots as little as possible. Although the results of experiments are somewhat conflicting, it is probably advisable in the South to use only the larger crowns for planting.

Crowns may be purchased from plant growers from $4 to $30 per 1,000. Those secured at the lower figure should weigh 75 to 80 pounds per 1,000, while well-grown crowns may weigh as much as 150 pounds or more per 1,000.

Job 3. Preparing the Soil and Planting the Crowns

SOIL PREFERENCES. The commercial plantings of asparagus in Georgia and South Carolina are located on sandy-loam soils of the Norfolk series. These soils are not very fertile and contain only a moderate amount of organic matter, but are well drained and respond to fertilization. Such soils are among the best for producing this crop. Even the coarse sands of the Sandhill region will grow good asparagus if well fertilized. Although clay or clay loam soils may produce greater yields than the lighter soils, they are not always satisfactory, because they are late and often produce crooked or deformed spears.

PREPARING THE SOIL FOR PLANTING. In most cases, preparation of the soil for planting asparagus in the southern states is best done in early spring. It is desirable that a green manure crop be plowed under in the fall preceding the planting and that the land be free from stumps and from coarse rubbish which might cause crooked spears. In making preparations for planting, it should be remembered that asparagus occupies the land for 15 years or longer and that the soil should therefore be put in good condition at the start. It should be as free as possible of weeds, particularly perennial weeds. Since deep planting of the crowns is commonly practiced, the soil should be plowed rather deeply.

PLANTING THE CROWNS. In the South, asparagus crowns may be set in the field from December 1 to April 1, depending upon the location and weather conditions. February is perhaps the best time in the localities where the crop is grown commercially. Furrows should be plowed out to a depth of 8 or 10 inches with a 2-horse turning plow, or middle buster. In these, the crowns are placed with buds 6 to 8 inches below the general ground level and covered about 2 inches deep. As the tops grow, the soil is gradually worked toward the plants until the furrows have been entirely filled. In some parts of the country shallow planting of crowns is recommended, but observations do not indicate that it is a desirable practice in the South, where such plantings produce stalks of small diameter.

The spacing of asparagus plants varies considerably in different sections of the country. Close planting may be practiced in home gardens, but plantings for commercial production in the South usually consist of rows 6 to 7 feet apart with the plants 18 to 24 inches apart in the row. Observations made by the South Carolina Experiment Station over a period of 8 years showed that a spacing of 2 by 5 feet, or not more than 2 by 6 feet, gave better yields, quantity and quality considered, than either the 2 by 4 or 2 by 8 feet spacing. These results are in line with similar data secured in Iowa and California. With a spacing of 2 by 5 feet, 4,356 crowns are required to plant an acre.

Job 4. Fertilizing, Liming, and Manuring

FERTILIZING. The cost of fertilizing asparagus is the largest single item of expense in its production. Fertilizer practices should therefore be carefully considered so that the outlay may be no more than is necessary. Due to the premium paid for the colossal grade, southern growers have a tendency to adjust fertilizer and other practices so as to secure as much of this grade as possible without due regard for the economics involved. If the increased yields from excessive amounts of fertilizer are not enough to offset the extra cost as compared with that of a moderate application, the use of the larger amount of fertilizer should be discontinued.

Kind and Amount of Fertilizer. Fertilizer mixtures such as a 5–7–5 [1] or a 4–8–4 are commonly used in asparagus growing. In tests conducted over a period of years by the South Carolina Experiment

[1] First figure, Nitrogen (N); second figure, Phosphorus (P_2O_5); and third, Potash (K_2O), as explained in Chapter 6.

Station, the basic treatment was a 5–7–5 mixture. The experiments were carried out on two soil types, Norfolk sand and a river bottom sandy loam. The results of these tests show that a complete mixture is necessary and that the use of 2,000 pounds of fertilizer was profitable under the conditions prevailing (Table 20). The increased yields from the use of 3,000 pounds of 5–7–5 as compared with 2,000 pounds did not appear to pay.

TABLE 20. THE EFFECT OF VARIOUS FERTILIZER TREATMENTS UPON THE YIELD OF ASPARAGUS GROWN ON TWO SOIL TYPES IN SOUTH CAROLINA

Amount, Kind, and Date of Applying Fertilizers	Analysis N–P–K	River Bottom Sandy Loam 1926–1930			Norfolk Sand 1925–1930		
		Total yield	Increase in yield over check plot		Total yield	Increase in yield over check plot	
		Pounds	*Pounds*	*Crates*	*Pounds*	*Pounds*	*Crates*
Rate of Application							
None	—	1,714	—	—	634	—	—
1,000 lbs.	5–7–5	2,420	706	28.2	969	335	13.4
2,000 lbs.	5–7–5	2,742	1,028	41.1	1,374	740	29.6
3,000 lbs.	5–7–5	2,690	976	39.0	1,409	775	31.0
Nitrogen Omitted							
2,000 lbs.	0–7–5	2,424	—	—	969	—	—
2,000 lbs.	5–7–5	2,742	318	12.7	1,374	405	16.2
2,000 lbs. plus 200 lbs.*	5–7–5 NaNO$_3$	2,540	116	4.6	1,522	553	22.1
Phosphorus Omitted							
2,000 lbs.	5–0–5	2,499	—	—	1,053	—	—
2,000 lbs.	5–7–5	2,742	243	9.7	1,374	321	12.8
Potash Omitted							
2,000 lbs.	5–7–0	2,133	—	—	1,102	—	—
2,000 lbs.	5–7–5	2,742	609	24.4	1,374	272	10.9
Time of Application							
2,000 lbs.*	5–7–5	2,251	—	—	1,262	—	—
1,000 lbs.* 1,000 lbs.	5–7–5 5–7–5	2,598	347	13.9	1,353	91	3.6
2,000 lbs.	5–7–5	2,742	491	19.6	1,374	112	4.5

A. M. Musser, S. C. Exp. Sta., unpublished data.

* Applied before the harvest season. All others applied after harvest.

Time of Applying Fertilizers. Considerable difference of opinion prevails as to the proper time for applying fertilizers to asparagus. Best results were obtained in the South Carolina tests when the complete fertilizer was applied after harvest. On the Norfolk sand, the use of

200 pounds of nitrate of soda applied in early spring before growth began resulted in a considerable increase in yield. On river bottom soil, extra nitrogen apparently did more harm than good. The Maryland Experiment Station found no significant difference in the yields from applications of a complete fertilizer before and after the harvest season.

Method of Applying Fertilizers. When the fertilizer is applied before the cutting season begins, the rows are barred off and the fertilizer broadcast by hand or with a lime spreader. Then when the rows are ridged, considerable mixing of the fertilizer with the soil occurs. When applications are made after harvest, the fertilizer is broadcast, and it is worked into the soil when the ridges are plowed down.

Fertilizer Recommendations. From observations and from the limited data available, it appears that about one ton per acre of a 5–7–5 or similar mixture, should be used in growing asparagus (Table 20). Although it is not entirely clear from the experimental work whether the fertilizer should be applied in early spring or after harvest, the data suggest that at least one-half or more should be reserved for applying after the cutting season. If all the nitrogen and potash is applied early in the spring, a considerable proportion may be lost by leaching before the plants can make use of them. Manure, where available, may be used at any rate up to 10 tons per acre, applied preferably in late fall. Where the asparagus did not make very good growth during the preceding summer and fall, an early spring application of nitrate of soda may increase the yield appreciably.

LIMING. On the strongly acid soils, sufficient lime should be applied to bring the reaction to *p*H [1] 6.0 to 6.5. Most of the asparagus soils in the southern states have a reaction of *p*H 4.5 to 6.5. Probably lime would improve the yields on many of these soils, although definite experimental data are lacking, particularly in regard to the benefits of lime where the soil is only mildly acid.

MANURING. Manure has long been regarded as an excellent fertilizer for asparagus. At the Maryland Experiment Station, a comparison of manure and chemical fertilizer on a fairly fertile loam soil showed that yields over a 9-year period were larger from the latter and were also much more profitable. In a separate experiment using sand cultures, practically devoid of organic matter, manure gave better results

[1] For explanation of *p*H in this and subsequent chapters, refer to definition and discussion on pages 63 and 64.

than the chemical fertilizers, suggesting that organic matter may be a limiting factor in certain sandy soils.

Job 5. Cultivating and Managing

CULTIVATING. Asparagus should be cultivated to keep down weeds and grass and thus encourage good top growth. Observations made at the South Carolina Experiment Station indicate that harvesting should not begin until after the plants have had two full growing seasons in the permanent bed.

When the plantation is old enough to allow harvesting, the rows should be moderately ridged before growth begins in the spring. Ridging may be done with an asparagus hiller, a turning plow, or a disk cultivator. There is a tendency to use rather high ridges in the South. According to unpublished data from South Carolina, extremely high ridges favor spears of larger diameter, but they reduce yields somewhat, whereas low ridges or no ridges at all result in spears of small diameter.

Following the harvest, the fertilizer is applied, the ridges are worked down, and the crop given level culture during the remainder of the season. A disk harrow can be used in leveling the ridges or they may be plowed down. Some hand work may be necessary in completing the leveling process. The ground along the rows should be left a little lower than the middles between the rows.

DISPOSING OF TOPS. There is some difference of opinion as to what disposition should be made of the tops at the end of the growing season. Burning the tops is apparently not of much help in the control of insects or diseases but may be the simplest method of disposal. Disking the tops into the soil will assist in maintaining the organic matter content. The tops should not be destroyed or disked in until they are dead, thus allowing complete translocation of sugars from the tops to the crowns.

After the tops have been disposed of, rye is sometimes planted to serve as a windbreak. Where this is done, a row of the grain is planted in every middle or every two or three middles. With the first warm weather in the spring, it will grow rapidly enough to furnish a good deal of protection from the wind by the time the cutting season is well under way.

LIFE OF ASPARAGUS PLANTATIONS. The life of an asparagus plantation depends upon natural conditions and upon the treatment received. Plantings are in existence which are said to have produced

FIG. 56. Asparagus is harvested by cutting the spears several inches below the ground with an asparagus knife.

profitable yields for more than a hundred years. In the South, commercial fields receiving average care remain profitable for 15 to 18 years, and yield their best crops at 5 to 10 years of age.

Job 6. Controlling Diseases and Insects

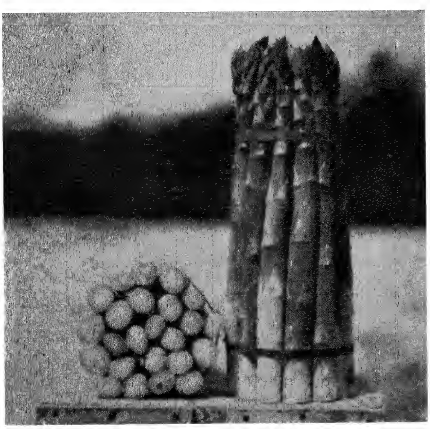
ASPARAGUS RUST. This disease is caused by *Puccinia asparagi*, injures the tops of the plant and limits the storage of reserve foods in the crowns, thereby reducing the crop of the following season. Rust does not occur on the marketed product. It appears first as small reddish yellow spots on the main stem and branches. The fungus produces spores in large numbers and these are disseminated by wind. The spots enlarge and become darker as the season advances, and the foliage turns brown and drops off, giving the plants a naked appearance.

Spraying and dusting are not usually sufficiently effective to warrant their use. The best defense is to use Mary Washington, which is partially resistant to the disease.

ASPARAGUS BEETLE. The asparagus beetle (*Crioceris asparagi*) is the most destructive insect attacking asparagus. It injures the spears during the harvest season and the full-grown tops later. The adult

beetle overwinters in rubbish surrounding cultivated fields and emerges in time to feed upon the developing spears, causing them to become crooked and unsightly. Eggs are deposited on the spears and later both adults and larvae attack the fully developed plants, defoliating them in some instances and giving them a setback which may be reflected in reduced yields the following season.

The beetle does not thrive in hot weather. Although it causes considerable damage in certain cases, it has not proven as troublesome in the South as elsewhere. The most serious damage is that done to the marketable spears and for which no remedy has been devised. The insect may be kept in check by dusting the mature plants with arsenicals (1 part of lead arsenate or calcium arsenate to 10 parts of hydrated lime). Where rust is not a serious disease, a few of the early spears may be left to develop into mature plants to attract the emerging beetles. As the insects collect on these, they may be destroyed by dusting with arsenicals, or the beetles may be knocked off the plants into shallow pans containing kerosene. The larvae can be destroyed by dusting with lime, and many will succumb if jarred from the plant during hot weather onto freshly cultivated soil.



S C Exp Sta

FIG. 57. The spears of fancy grade asparagus range from ½ to 1⅛ inch in diameter.

Job 7. Harvesting, Processing, and Marketing

HARVESTING. As indicated previously, harvesting is sometimes started the next spring after planting, but it is perhaps best to delay until the bed is 2 years old. The first cutting season should be limited to 2 weeks, if started when the bed is one year old, and to not more than 3 weeks when delayed until the second spring.

The spears are cut when they have grown 5 to 8 inches above the surface of the ground. In cutting, the spears are severed several inches below the surface by means of an asparagus knife (Fig. 56). They are collected in baskets and taken to the packing shed. Cutting is done

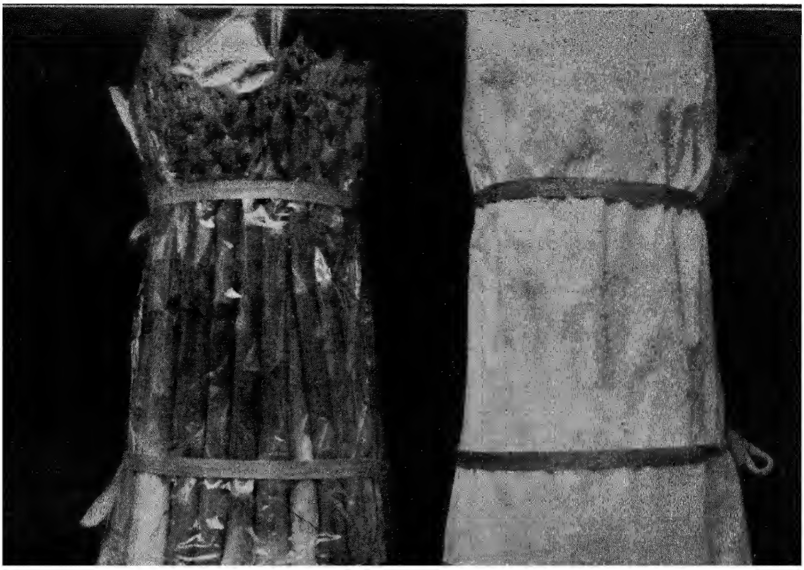


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FIG 58. Bunches of asparagus: Wrapped in cellophane on the left, and paper on the right.

preferably in the morning and as frequently as is necessary, which may be every day or only every 2 or 3 days, depending on the temperature and other growing conditions. Care should be exercised in cutting the asparagus in order to avoid injuring the younger spears. Tests in Massachusetts have shown that there is great variation in the quality and quantity of asparagus harvested from similar areas by different individuals, depending on the care used in cutting.

Yields of asparagus vary greatly, depending on the age of the plants, fertilization, and cultural methods. Although the average production in the South is from 40 to 50 crates per acre, yields of 75 to 100 or more crates are secured by some growers.

GRADING, BUNCHING, AND PACKING. The returns from asparagus growing depend in a large measure upon proper grading, bunching, and packing. Usually only No. 1 asparagus is shipped from the South. The spears are first separated into three grades, Colossal, Fancy, and Choice, depending upon their diameter. The diameters of the spears included in each grade are as follows: Extra Colossal, $\frac{7}{8}$ inch and over; Colossal, $\frac{11}{16}$ to $\frac{7}{8}$ inch; Fancy, $\frac{1}{2}$ to $\frac{11}{16}$ inch (Fig. 57);

and Choice, $\frac{1}{4}$ to $\frac{1}{2}$ inch. Bunches of asparagus are normally $8\frac{1}{2}$ inches long but in recent years 10-inch bunches also are shipped, 50 per cent or more of the southern crop being of this length. Extra Colossal is always 10 inches long and the other grades may be of that length. All stalks should be straight, unblemished, and fresh.

In bunching, the required number of spears are placed with the tips even in a bunching machine, the bunch is clamped and tied firmly near each end with red or blue tape, or held together with colored rubber

FIG. 59. The bulk of asparagus is packed in crates, assembled at central shipping points, and moved to northern markets in iced refrigerator cars.

bands (Fig. 58). The butts are then cut squarely with a large knife, leaving the bunch either $8\frac{1}{2}$ or 10 inches in length. Twelve of the 2 to $2\frac{1}{2}$ pound bunches are placed in a crate which has a pyramidal shape that assures a tight pack. Before packing, the bottom of the crate is lined with waxed paper on which is placed a layer of moist sphagnum moss, on which the bunches of asparagus are set with the butts down. Unless kept at temperatures near the freezing point, the quality of asparagus deteriorates rapidly and the spears continue growing, thus causing loose bunches of ragged appearance. The packed crates should therefore be put into iced cars as promptly as possible. On local markets, one-pound or smaller bunches may be preferred, or the asparagus may be sold without grading or bunching.

MARKETING. Most of the commercial crop of asparagus in the South is marketed through growers associations, which are among the best managed farmers' organizations in this region. Strict regulations have been established for the grading and packing of asparagus, which have enabled a standardized product to be put on the market (Fig. 59).

The bulk of the crop is shipped north in iced refrigerator cars; however, in early spring before there is sufficient volume for carlot shipments, most of the movement is by express. Truck shipments account for a considerable percentage of the total movement of asparagus.

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15

BEANS (SNAP AND LIMA)

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CLASSIFICATION, ORIGIN, AND HISTORY. The snap or kidney bean (*Phaseolus vulgaris*) was grown by the Indians over a considerable part of both North and South America, and was carried to Europe by early settlers. The species includes field beans as well as varieties used in the green or immature stage. Snap beans have thick-walled pods that are free from strings (bast fibers) in the early stages of development.

Table 21. Estimated Commercial Acreage, Production, Value, Carlot Shipment, and Shipping Season of Snap Beans (Market) in Important Southern and Other Leading States, 1929–1935 Average

States	Acreage	Yield per Acre	Production [1]	Price per Bushel	Farm Value	Carlot Shipments [2]	Principal Shipping Season
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
Florida . . .	46,414	92	4,252	1.42	5,865	6,179	Oct.–May
Louisiana . .	9,729	66	642	.88	568	772	May, Oct., Nov.
Texas . . .	8,990	67	598	1.30	706	398	Apr., May–Nov.
North Carolina	8,114	79	645	.74	420	672	May, June
South Carolina	5,486	85	467	.87	359	561	May, June
Mississippi . .	4,347	63	272	.84	225	274	May
Virginia . . .	3,829	107	409	.96	378	590	May–Oct.
Georgia . . .	2,947	65	187	.77	102	138	May, June
Other states							
New Jersey . .	12,600	103	1,292	.84	1,090	105	June–Aug.
California . .	5,610	132	740	1.26	929	124	Apr.–Nov.
Maryland . .	4,389	97	427	.99	423	265	June–Aug.
Total (average) for the 20 leading states	122,151	89	10,880	1.13	11,875	10,420	Jan.–Dec.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments. Beginning 1931, figures include lima beans in pod.

The lima bean (*Phaseolus limensis*) is a native of tropical America. It grows wild in Brazil, and its seeds have been found in Peruvian tombs at Pachacamac and Ancon. The name "Lima" probably comes from Lima, Peru, where large lima beans were secured and imported to the United States.

SCOPE AND IMPORTANCE. California has long been noted for the production of dry lima beans, while Florida leads in snap bean production. Since snap beans are harvested in the immature stage, home production of this crop extends well into the colder parts of the world. The upper South ships much of the crop in trucks, while Louisiana usually ships from 700 to 800 cars by rail. Maryland and California can a considerable quantity of limas. Table 21 gives data on the commercial crop, which comes largely from the southern states.

AVERAGE PRODUCTION COSTS. Production costs vary considerably from section to section. Cost studies conducted in South Carolina in 1929, 1931, and 1932 show that approximately $60 is required to produce and harvest an acre of snap beans, the principal costs being labor, fertilizers, seed, and containers.

CLIMATIC REQUIREMENTS. Beans are sensitive to frost and must be produced during the frost-free period of the year. Limas require about 4 months of such temperatures, including warm nights, while snap beans may mature in 50 to 60 days. Table D in the APPENDIX lists the number of frost-free days for many of the southern states. The relatively long, warm season required limits commercial production of lima beans to the warmer sections. Pole snap beans, common in home plantings, require a longer season than the bush type.

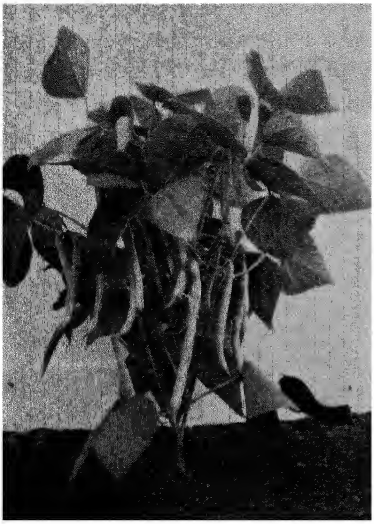
Job 1. Selecting Varieties of Seed

VARIETIES. Snap or garden beans have been handicapped by the use of many synonymous names, but the development of many varieties and types is to be expected with a popular crop so widely distributed. Stringless Green Refugee is a popular canning type, except in Maryland and Delaware where Giant Stringless is used. Holder and Hunter state that the Refugee varieties have given poor yields both in plot tests and field trials in Maryland. Stringless Green Pod selections yield well and are generally well suited for market purposes (Fig. 60); the Tendergreen is a newer variety that has been reported promising in Tennessee and Texas; and the Tennessee Green Pod is noted for earliness and is fairly

productive, but lacks quality. Wax beans are popular both for home gardens and for market, but usually yield less than the green varieties. Pencil Pod is one of the leading Wax varieties in the South. A parallel description of the outstanding characteristics of the principal varieties of snap beans is given in Table 22.

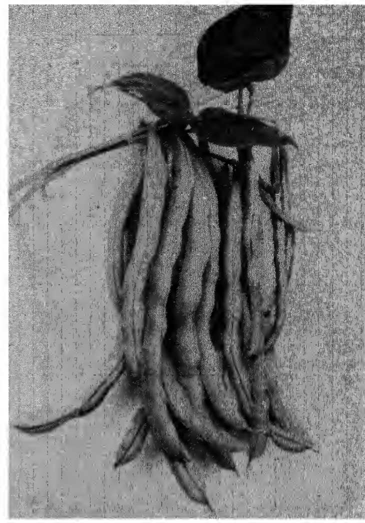
TABLE 22. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF SNAP BEANS

VARIETY	CHIEF USE	SEASON	SIZE AND HABIT OF PLANT	POD			
				Shape — longitudinal and cross section	Color	Fiber	Dry seed color
Asgrow Stringless Green Pod	home, market, canning	early	large, bush	straight, round	medium green	none	mottled brown and purple
Bountiful	home, market	early	medium, bush	straight, flat	light green	very slight	yellow straw
Burpee Stringless Green Pod	home, market	early	medium, bush	curved, round	medium green	none	coffee brown
Giant Stringless Green Pod	home, market, canning	early	medium, bush	slightly curved, round	medium green	none	yellowish brown
Kentucky Wonder	home, market, canning	mid-season	large, pole	curved, round	medium green	none	buff brown
Kidney Wax	home, market, canning	mid-season	medium, bush	curved, semi-round	medium yellow	none	white, black eye ring
McCaslan	home, market, dry	mid-season	large, pole	curved, thick, flat	medium green	none	ivory white
Pencil Pod	home, market	second early	medium, bush	curved, round	medium yellow	none	black
Red Valentine	market	second early	medium, bush	curved, round	medium green	slight	mottled fawn and red
Refugee	home, market, canning	late	large, bush	straight, round	light green	slight	mottled brown and purple
Tendergreen	home, market	early	medium, bush	straight, round	medium dark green	none	brownish black
Tennessee Green Pod	home, market	very early	small, bush	slightly curved, flat	medium green	medium	solid medium brown



Associated Seed Growers, Inc

FIG. 60. Stringless Green Pod, bush bean.



Associated Seed Growers, Inc

FIG 61. Kentucky Wonder, a leading pole snap bean.

Pole or climbing beans are productive and are common in home plantings, especially in corn. Kentucky Wonder has long been a leading variety, although it is susceptible to bean rust (Fig. 61). Blue Lake is a California canning variety, and Mammoth Horticultural is recommended by Amstein for planting in Arkansas.

Early Carolina or Sieva is the common butter-bean of the South, where large yields and hardiness make it an outstanding variety. Several southern experiment stations report that it yields about twice as much as the better, large-seeded varieties. Henderson Bush (Baby Lima) is used for canning and is popular in home gardens. White-seeded selections of the Hopi type are valued in the West because of hardiness to a hot, dry climate. Some selections are being tried in the Southeast because of resistance to nematodes, and the better strains gave good yields at the Tennessee Experiment Station.

Although large-seeded lima varieties blossom freely, they often fail to set satisfactory crops in the southern states. However, the Fordhook has done fairly well in some sections (Fig. 62); the Jackson Wonder, a strong-flavored, colored bush lima, yields well under most conditions; and Wood Prolific, a white bush lima bean, is reported to be a good variety in Alabama.

SECURING SEED. A number of serious bean diseases, such as anthracnose, are carried in the seed, and for this reason it is a great advantage to secure seed from relatively disease-free fields or sections. Low humidity and limited rainfall are unfavorable to the development of bean blight, anthracnose, and mosaic. Roguing seed fields is necessary to maintain a strain of high quality and true to type. The bean is usually a self-fertilized plant, but a certain amount of crossing may occur when two varieties are grown side by side, so that an occasional sport plant is to be expected. Seed injured in threshing germinates poorly. Most of the bean seed is produced in California and the Northwest.

Francis C Stokes and Co., Inc

FIG. 62. Fordhook, large-seeded lima.

Job 2. Preparing the Soil

SOIL PREFERENCES. The bean is a universal crop in the United States, and can be grown on soils that range from sand to clay and peat. On sandy soils, beans mature in a shorter time than on the heavier soils. High moisture content and high nitrogen delay maturity. Most growers prefer a well-drained, fairly fertile loam soil containing considerable humus. Soils more acid than *p*H 5.5 should usually be limed. Lima beans have a similar soil requirement to the garden varieties, but are even more sensitive to a cold, water-soaked soil. Northern border sections need to be especially careful to select warm soils for lima beans to hasten the maturity of the crop.

PREPARING THE SEED BED. Bean cotyledons push up through the soil in germination, and need a well-prepared seedbed. A well-prepared, firm seedbed also saves cultivation costs after the crop is planted. Beans thrive after a cultivated crop, partly because of freedom from weeds. Sod land to be planted to beans is best plowed in the fall.

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FIG. 63 Complete fertilizers materially increase vegetative growth and production of beans on thin land. Left, 1,000 pounds 5–10–5 per acre; right, no fertilizer.

Job 3. Fertilizing and Manuring

FERTILIZING. The quick-maturing garden bean varieties need liberal mineral fertilizers, especially superphosphate and potash. Maryland suggests from 400 to 600 pounds per acre of a 4–12–6, nitrogen, phosphoric acid, and potash mixture. Alabama advises from 1,000 to 1,500 pounds of a 4–8–4 fertilizer on lima beans if the soil is of low fertility. Two hundred to 400 pounds of a 4–8–4 fertilizer per acre, on a 3½-foot row basis, is generally recommended at planting time in the spring under Louisiana conditions.

In general, lima beans and pole varieties of snap beans need somewhat more fertilizer than dwarf snap beans. Most growers have found that heavy applications of mineral fertilizers in the drill are likely to injure seed germination, but where the fertilizer is placed 2 to 3 inches to the side of the row and 2 inches deep, good results have been obtained. Snap beans for canning purposes are often grown with limited fertilizer applications on good soils (Fig. 63).

MANURING. Soils of low humus content need a green-manure crop in the rotation. Stable manure is usually high in nitrogen and can be used

to best advantage on other crops. The Alabama Experiment Station secured good yields of lima beans using six tons of manure per acre on soil of low fertility.

Job 4. Planting and Cultivating

PLANTING. In certain sections of Texas, early planting of lima beans is favored in order to avoid very hot and dry weather late in the season. Home plantings of early garden varieties are often made before all danger of frost is over, and a later planting is made for the main crop. Most plantings of both lima and snap beans are best made after the soil is warm and danger of frost is over. A fall crop is often grown in many sections of the South; and in Florida, most of the plantings are made during the fall and winter.

Pole varieties of snap beans and pole limas are commonly planted in hills 3 to 4 feet apart each way, with five or six seeds planted in each hill, and later thinned to three or four plants. Unsupported pole limas are grown in drills, in California. Garden varieties of the bush type are commonly spaced 2 to 4 inches apart in drills, with the closer spacings usually producing larger yields, but requiring more seed per acre. Gillis found that at the rate of six seeds per foot and rows 3 feet apart, it would require 90 pounds of Stringless Green Pod seed to plant an acre. Ordinarily, about 50 pounds of snap bean seed of average size are planted to the acre. Large-seeded varieties would increase this amount, and small-seeded ones would decrease it. Tennessee Green Pod is a small-growing variety and can be spaced somewhat closer. Fertile soils and irrigation tend to produce larger plants, and more space should be provided. The average rate and method of planting different kinds of beans in the South are given in Table 10.

CULTIVATING. It is not advisable to cultivate or to work among bean plants when the foliage is wet, because anthracnose and other fungous spores are easily distributed in this way. Cultivation and hoeing, which are employed primarily to keep down and destroy weeds, should start when the bean plants first appear above ground, and should be shallow, especially as the plants approach maturity. Many of the feeding roots of beans are near the surface and are easily injured by deep cultivation. A good site for beans should be relatively free from weeds, as it reduces the cost of production and lessens the chance of injury to the roots.

SUPPORTING VINES. The dry climate of certain sections in California enables farmers to grow both pole and bush varieties without

support. Staking or trellising is expensive, but necessary with pole varieties in humid regions, since pods touching or near the surface of the ground are usually injured. A common method of staking is to put an 8- or 9-foot pole at each hill and tie the tops of four stakes together. Such poles should be set before the beans are planted, or very soon after.

Job 5. Controlling Diseases and Insects

DISEASES. Usually, lima beans are injured less by diseases than are snap varieties. General control measures include using disease-free seed, rotating crops, disposing of diseased bean refuse, using resistant varieties, and working the plants only when the foliage is dry.

Anthracnose, caused by *Colletotrichum lindemuthianum*, is a destructive fungous disease of snap and field beans grown in humid regions. Hot and dry weather is unfavorable for the development of anthracnose. There are several strains of this fungus which overwinters in the seed and in bean refuse. The somewhat circular, dark, sunken spots are easily recognized on the pods and stems. Affected areas on the leaves become discolored and die. Most snap varieties show little resistance. The term "rust-proof," as used by seedsmen, refers to this disease, but anthracnose should not be confused with bean rust, which is caused by another organism, as is later discussed.

Bacterial blight, associated with *Bacterium phaseoli*, is common on snap beans in the central and eastern part of the United States. Diseased spots on the pods appear water-soaked, changing to a reddish brown, and infected seeds are yellowish or yellow blotched. Control measures are similar to those for anthracnose. A bacterial spot (*B. Vignae*) attacks pods, leaves, and stems of lima varieties.

Rust, caused by *Uromyces appendiculatus*, is widely distributed over eastern United States, occurs in the coastal section along the Pacific coast, and is especially destructive on Kentucky Wonder. Lesions may appear on all aerial parts of the plant, but is more destructive on the leaves. Resistant varieties such as Burpee's Stringless, Pencil Pod, Refugee, and Horticultural Pole are commonly recommended.

INSECTS. Bean insects cause widespread destruction of this crop, especially in home gardens where satisfactory control measures are difficult to carry out. The rapid spread of the Mexican bean beetle in recent years has greatly increased control problems.

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FIG. 64 Left — Yield of beans from a row sprayed with cryolite
Right — Yield from a check row unsprayed

The Mexican bean beetle (*Epilachna corrupta*), believed to be a native of Mexico, has been present in western United States since 1850, and is now rapidly spreading over the eastern states. It prefers to feed on snap beans, field beans, and lima beans, but beggarweed is a common food plant. The beetles usually appear before the beans start to blossom, and after feeding for a week or 10 days, they start to deposit their eggs. Reproduction is rapid, since the average female lays more than 400 eggs. The insect passes the winter as an adult. The young larvae are more easily killed than the adults. Turning under vines immediately after harvest removes the food supply, and helps in control.

Magnesium arsenate spray composed of 2 pounds per 100 gallons of solution has given good control with a minimum of injury to bean foliage This spray solution must be applied to the underside of the leaves. Several applications are necessary. Marcovitch and Stanley have received striking control (Fig. 64) with Alorco cryolite, using 3 pounds to 100 gallons of solution, and applying the spray in several applications before the pods form. These poisons should not be applied after the pods begin to form.

The adult bean weevil (*Bruchus obtectus*) is a small dull-colored beetle, and the larva is white. It is chiefly a pest of dry beans, including bean seed. Infested seed should not be planted, as germination is poor and adults emerging from such seed may infect the next crop. The seed should be fumigated, using 3 to 8 pounds of carbon bisulfide to each 1,000 cubic feet of space. This treatment should be given early in the storage period before much injury has occurred.

Job 6. Harvesting, Processing, and Marketing

PICKING. Bush varieties mature over a relatively short time and require several pickings. Snap beans are picked when the pods are nearly full size and the beans small, about one-fourth developed. Green-shell limas are picked when the seeds are nearly full size and the pods are green. Less mature limas bring a slightly higher price but yield less. Lima beans for canning are cut by a mowing machine and shelled by machinery.

GRADING AND PACKING. Snap beans should be carefully sorted for shipment. Grade standards change, and the latest specifications can be secured from the Bureau of Agricultural Economics of the United States Department of Agriculture.

Lima beans handle and ship best in pods, but are often sold shelled. Both snap and green limas need prompt refrigeration after picking. Bunker icing permits snap beans to be kept dry and reduces the amount of soft rot. Hampers, half-bushel and bushel baskets are common packages.

MARKETING. A large part of the Florida crop of snap beans is shipped in refrigerator cars to northern markets during winter and early spring, but trucks haul much of the crop that is grown in the regions farther north. Immature beans wilt quickly after picking if the weather is hot, and truck shipments need cooling. Shelled lima beans are usually put up in quart boxes, which are packed in berry crates.

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16

CABBAGE

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CLASSIFICATION, ORIGIN, AND HISTORY. Cabbage (*Brassica oleracea* var. *capitata*) is the most important member of the *Cruciferae* or mustard family. It is generally conceded that our present-day varieties of cabbage originated from the wild cabbage which is found growing along the chalky coasts of the sea provinces of England and along the western and southern coasts of Europe. Cabbage has been used as a food crop since earliest antiquity. The ancient Greeks held it in high esteem, and their fables claim its origin from the father of their gods. The Egyptians are said to have worshiped cabbage. Today it still remains one of the leading vegetable crops of the world.

SCOPE AND IMPORTANCE. Cabbage is one of the most widely grown vegetables in the United States. It is grown in most home gardens, and in a large percentage of the market gardens and truck farms. It was one of the first crops to be grown in the South for northern shipments, and is today one of the most widely planted winter truck crops. Because of its wide range of climate and soil adaptability, its economical production, and its general use as a food crop, cabbage is always found throughout the year on the American markets. Cabbage is widely known as a health food. It has a basic reaction and ranks high in its general food properties, particularly in vitamins B and C; and in minerals, being especially rich in calcium.

Fresh cabbage is marketed generally throughout the United States every month of the year. In the North, New York and Wisconsin are the two leading states. In the northern states, a large percentage of the cabbage is grown as a late crop for storage and for kraut. The storage cabbage is removed for sale throughout the winter, particularly during early winter. After midwinter, competition is keen from the new southern cabbage crop, which usually sells for considerably more than the stored product.

While many of the southern states could begin shipping fall cabbage around October, it is usually not profitable to make shipments before

January. This means that the midwinter and early spring crops are the most profitable. Shipments usually start from south Texas and south Florida, and as the spring advances, the shipping centers move north. Table 23 shows the acreage, yield, production, value, and shipping season of important southern and other leading states.

TABLE 23. COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF CABBAGE (MARKET AND KRAUT) IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [1]	PRICE PER TON	FARM VALUE	CARLOT SHIPMENTS [2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Short tons	Short tons	Dollars	1,000 Dollars	Cars	By months
Texas	24,186	5.2	126,471	16.89	1,876	5,970	Jan.–April
Virginia	6,933	4.6	31,857	22.47	658	1,700	May, June
Florida	6,386	6.1	38,757	31.52	1,064	2,656	Dec.–April
Mississippi	3,850	5.0	19,071	22.56	410	1,278	Apr.–June
South Carolina	3,329	8.5	28,229	33.10	886	1,801	Apr., May
Louisiana	2,829	4.2	11,786	21.30	245	489	May, June
Tennessee	2,107	6.1	12,800	21.95	281	751	June
Alabama	1,890	5.8	10,971	22.53	216	798	Apr., May
Other States							
New York	33,010	8.6	285,014	9.50	2,691	9,380	Aug.–Mar.
Wisconsin	19,546	7.0	137,600	8.54	1,175	4,497	Sept.–Jan.
Total (average) for the 30 leading states	147,166	6.8	996,571	13.99	13,482	33,526	Jan.–Dec.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

AVERAGE PRODUCTION COSTS. Compared with other major truck crops, cabbage is comparatively inexpensive to produce. The chief items of cost, including fertilizer, method of planting to the field, and irrigation water, vary from section to section. Planting the seed in place is cheaper than transplanting. The growing cost in Louisiana does not exceed $30 per acre in some instances. The cost of crates and selling charges amount to about $30 per acre when there is an average yield of five tons per acre. When shipments are made in bulk, this cost is considerably less. In most other cabbage-growing regions of the South, the cost of growing is higher than the figures given for Louisiana.

CLIMATIC REQUIREMENTS. Cabbage is a hardy cool-season crop and is at its best during a cool moist period. Although cabbage has its optimum growing conditions, it will stand greater weather variations of both heat and cold than any other of our major truck crops. Plantings of cabbage are made in the South from July to April during a period of weather extremes.

Young cabbage plants of the Wakefield group, if well hardened, will stand temperature as low as 15° F. without serious damage. However, most varieties, particularly those of the Copenhagen type, will not stand temperatures below 20° F., and in this case, the plants must be well hardened.

Job 1. Selecting Varieties and Seed

In selecting a variety, one must consider such factors as market demand, cold and disease resistance, season of the year to be planted, and resistance to premature seeding.

TYPES AND VARIETIES. Myers in 1913, Drewes and Coulter in 1934, and Boswell and his associates in 1934, have grouped, classified, and completely described most of the varieties existing in the United States. Almost all of the leading varieties of cabbage are grown in the South, with probably the exception of the Danish type. The All Head Early and other domestic types are extensively planted in south Texas, while in Louisiana and Mississippi the Copenhagen types are planted for late spring shipments. Since the Jersey types are hardier than most varieties, they are planted in Louisiana, Alabama, Florida, South Carolina, and Virginia for early spring sales. In Virginia and

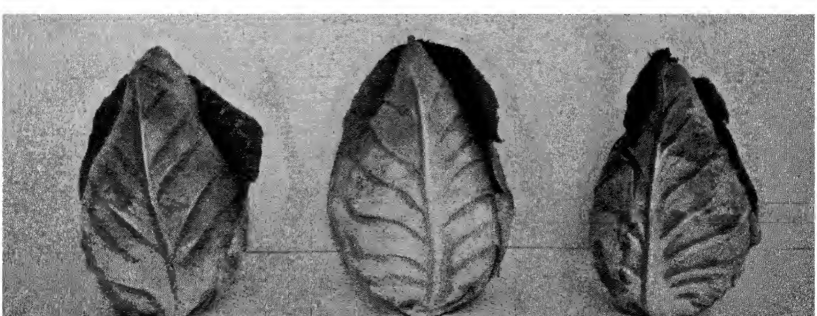

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FIG. 65. Good heads of the Jersey Wakefield cabbage, a desirable first-early variety.

South Carolina, plantings of the Charleston Wakefield variety (Fig. 65) are made to the field as early as November.

The outstanding characteristics of the principal varieties of cabbage grown in the South are given in Table 24.

TABLE 24. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF CABBAGE

Variety	Chief Use	Season	Plant Size	Leaf Color	Head		
					Weight in pounds	Shape	Firmness
All Head Early	home, shipping, kraut	early mid-season	large	gray green	5–6	deep, flat	firm
Charleston Wakefield	home, market	second early	medium	dark green	$3\frac{1}{2}$–$4\frac{1}{2}$	pointed	medium
Copenhagen Market	home, market, shipping	early	medium	gray green	3–4	globular	firm
Early Jersey Wakefield	home, market	first early	small	dark green	2–$2\frac{1}{2}$	pointed	medium
Glory of Enkhuizen	home, market, shipping, kraut	mid-season	large	gray green	5–7	globular	firm
Golden Acre	home, market, shipping	early	small	medium gray green	2–3	globular	medium firm
Late Flat Dutch	general purpose	late mid-season	very large	light gray green	6–9	flat	firm
Red Rock	salad and decorative	late	large	purplish red	6–7	round	very firm
Savoy Perfection Drumhead	home, market, shipping	late	medium large	dark green	5–6	globular	medium
Stein's Early Flat Dutch	home, market, kraut	mid-season	very large	gray green	6–9	flat	firm
Succession	general purpose	mid-season	medium	dark green	6–8	flat	medium

SECURING SEED. Up until about 1915, most of the cabbage seed was imported from Europe, chiefly from Denmark and Holland. In recent years, however, many of the American seedsmen have been growing their own seed in the Puget Sound district, centering around Mount Vernon, Washington. Long Island, New York, is the oldest cabbage seed-producing district in the United States; but recently,

production in that area has been reduced in favor of the Puget Sound region. The ease with which members of the cabbage family cross makes it a difficult problem to maintain pure stock. For this reason, it is well to buy seed from growers who are interested in cabbage seed production themselves and who maintain reliable stocks. In buying seed, a record should be kept of the stock number so the particular strain or stock can be duplicated another season if desired.

Job 2. Preparing the Soil

SOIL PREFERENCES. For fall and early winter planting, cabbage does best on the heavier loam soils, while the spring crop does best on a sandy or sandy loam. The sandy soils drain better and naturally are warmer than the heavier soil types. The heavier types of cabbage soils are those of the alluvial type found in Louisiana and Texas, while the sandier ones are to be found along the Atlantic and Gulf coasts, of which the Charleston, South Carolina, district is typical. While the cabbage crop requires an abundant supply of water, good drainage is very necessary. The soil should contain a liberal supply of organic matter.

PREPARING THE SEED BED. A green-manure crop should be turned under at least a month in advance of planting. The land should be disked and the rows prepared a week or 10 days before planting. The disk cultivator is a good tool with which to prepare the rows as it pulverizes the soil thoroughly. Heavy soil should be sufficiently harrowed before planting.

Job 3. Fertilizing, Liming, and Manuring

FERTILIZING. Cabbage is a gross feeder, and liberal applications of fertilizer are made in most of the producing areas of the South. From Virginia down the Atlantic Coast to Florida, and in Florida, Alabama, and Mississippi, the usual application of complete fertilizer is from 1,000 to 2,000 pounds of a 7–8–5, 9–5–4, or 4–8–4 per acre. In addition, the usual practice is to apply 400 to 600 pounds of nitrate of soda as a top dressing. Very little fertilizer is used in cabbage production in Texas, although some growers find it profitable.

In the alluvial sections of Louisiana, the Louisiana Agricultural Experiment Station has found it profitable to apply 600 pounds of a complete fertilizer analyzing 4–12–4 for the fall and winter crops and 800 pounds of the same fertilizer for the spring crop. In addition to this, 200 pounds of

nitrate of soda should be applied in two applications of 100 pounds each. The first application of nitrate of soda is best applied 2 weeks after transplanting and the second application when the largest leaves reach the size of a man's hand. In some sections the fertilizer is usually applied in the bottom of an open furrow over which the ridge is made. In other regions the fertilizer is applied broadcast. The fertilizer should be applied at least a week in advance of transplanting. Where the transplanting and fertilizer-distributing machinery are in combination, it is recommended that fertilizer be applied in bands on each side of the plants.

LIMING. Cabbage grows best where the *p*H range is from 6.0 to 6.5. Where the soil is more acid than this, an application of lime will be beneficial. At the Fruit and Truck Experiment Station, Hammond, Louisiana, where the soil reaction was *p*H 5.0, an application of 1,000 pounds of lime per acre doubled the yield of spring cabbage. Most of the cabbage soils of the South, with the exception of Texas, are acid with the *p*H ranging from 5.0 to 6.0. Therefore, it would seem profitable to lime such soils.

MANURING. In most sections of the South, it is an established practice to turn under a green-manure crop each year some time in advance of planting cabbage. Some type of organic matter turned into the soil once a year is necessary to maintain the proper physical condition. Soybeans, cowpeas, or velvet beans are the cover crops most commonly used. With the planting of these soil-improving crops and the application of commercial fertilizer, high crop production can be maintained. In the South, very little stable manure is applied to cabbage; however, in some of the market garden areas, such as those around New Orleans, cow manure applied at the rate of 15 tons plus 500 pounds of the complete fertilizer per acre has given very satisfactory results. There are more weeds to contend with where stable manure is used than where the green manure has been turned under as a source of organic matter.

Job 4. Planting and Cultivating

GROWING PLANTS. There are three distinct methods of plant growing used in the South:

(1) **Planting directly in the field.** This method is growing in favor with the larger growers, particularly throughout Louisiana and Texas. With this method, seeding can be done with machinery. It

is adapted also for planting during the summer when transplanting is very difficult. On sandy soil, irrigation is necessary to insure stands. On heavier soils, a stand can be obtained when the rainfall is well distributed. Before planting, the land should be well settled by rains or irrigation. The seed is drilled at the rate of 3 pounds per acre and given shallow covering, especially on heavy soils, the soil being firmed with a roller after planting. When the plants have grown to the usual transplanting size, some thinning is usually necessary, the plants that are removed being either sold or transplanted to other fields. The plants seeded direct to the field usually mature 2 or 3 weeks before transplanted plants of the same age.

(2) **Planting on open field beds.** In practicing this method, land is prepared in beds of convenient width, usually 5 to 6 feet, and the seed is drilled in rows 4 to 6 inches apart. In some cases the seeds are sown broadcast over the bed. The row system is recommended as it is more convenient to care for the plants properly. This method is used extensively in plant-producing areas around Charleston, South Carolina. Where this method is used, seeding in the beds is usually done during fall — September and October — depending somewhat upon the locality.

(3) **Planting in cold frames.** This method of plant production is used extensively in the interior cabbage-production areas such as the Crystal Springs area of Mississippi. Cautious growers along the Gulf and Atlantic coasts use this method along with the open field beds as a precautionary measure so as to have reserve plants in case of a heavy

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FIG. 66. A convenient cold frame for growing early cabbage plants can be covered with canvas during frosty nights.

freeze. The cold frames are usually covered with cotton sheeting (Fig. 66). This sheeting is covered, in the event of severe weather, with a deep layer of pine straw, broom straw, or hay. When using the cold-frame method, the seed can be planted about a month later than when the open-bed method is used, and still have plants for transplanting about the same time. Where the bed method is used, seed and plants are conserved, for it usually requires from $\frac{1}{4}$ to $\frac{1}{3}$ of a pound of seed per acre.

SETTING PLANTS. Although some machinery is used for transplanting, most of it is done by hand since labor is usually not a problem in the South. When transplanting is done during late summer and early fall, only large, stocky plants should be used; and these should be watered and the soil firmed about the roots. In the trucking areas from Virginia to Georgia, many of the plantings for the spring crop are set in the field in late fall and early winter. The plants make very little top growth during the winter, but as spring opens, they begin to grow and usually mature earlier than spring-set plants. In Texas and Florida, commercial plantings are made during fall and winter. In Alabama, Louisiana, and Mississippi, plants are seldom set in the field before January for the spring shipments. The planting distances in the row for cabbage are usually 12 to 18 inches for the Jersey and Copenhagen types, and 18 to 20 inches for domestic varieties such as the All Head Early and Flat Dutch. The width between the rows varies from 28 inches to 4 feet, depending upon the soil type, and methods of irrigation and drainage used.

CULTIVATING. Cabbage has an extensive shallow-root system. Deep cultivation should not be used except when the soil becomes very hard and then only when the plants are small. After that, shallow cultivation should be practiced. For the fall and spring crops, it is usually necessary to make three cultivations, while the winter crop requires less attention. The tools generally used in cultivating are spring-tooth and disk cultivators. Cultivation should be discontinued when the plants start to head.

NORMAL AND PREMATURE SEEDING. Investigations by Miller at Cornell University and at the Louisiana Agricultural Experiment Station, and findings by Boswell, have shown that the single factor most closely associated with premature seeding is the size of the plants when exposed to the low temperature. Small plants having leaves about 1 to $1\frac{1}{2}$ inches wide can stand low temperature for 6 months

without going to seed. However, if the plants are large, having leaves 2 to 3 inches wide, many of them will shoot seed-stalks if exposed to continuous cold weather, 40° to 50° F., for a period of 30 to 60 days. The longer the period of exposure, the higher will be the percentage of plants producing seed-stalks. Some varieties and strains are more subject to premature seeding than others. The Copenhagen Market variety is more subject to bolting than the Jersey varieties. It is clearly evident that strains can be bred that are highly resistant to premature seeding. About the best control measures are to (1) use the best strains of seed available, (2) avoid setting plants too early to the field, and (3) prevent the stimulation of early plant growth. The plants should be relatively small during midwinter when there is continuous low temperature. It is not the freezing temperature that causes premature seeding but a very low growing temperature that initiates seed-stalk formation.

BREEDING METHODS. Two distinct methods are being used in conducting cabbage breeding at the Louisiana Agricultural Experiment Station. With both methods, seeds are planted to the field in July and August and mature plants are ready for selection the last of October and the first of November. In Method No. 1, the plants

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FIG 67 Plants of two distinct strains of Copenhagen cabbage.

are selected, the outer leaves removed, and the plants are lifted and placed in cold storage at a temperature of 40° F. for a period of 2 months. At the end of this time, plants can be removed, set in the field, or placed in pots in the greenhouse for seed production. In Method No. 2, the plants are selected, and the heads are cut and examined for internal characters such as short core and compactness. If the internal characters are desirable, the plants are staked and allowed to remain until the rosette buds grow out and have leaves 4 to 5 inches long. At this time, all the selected plants are removed to the breeding plot for seed production. During this operation, all of the old leaves are removed and also all of the rosette buds except five. These are allowed to develop into seed-stalks. Method No. 2 is much better most of the time since it allows internal study of the head characters and a higher yield of seed in normal years. However, if the winter is unusually warm, Method No. 1 is best. With the stored heads at 40° F., seed-stalk formation is initiated, and when these heads are removed early in the winter and placed in the greenhouse or set into the field, flower formation results. As a safety measure, both methods should be employed each year.

Figures 67 and 68 show how exterior and interior characters of cabbage can be influenced by breeding methods.

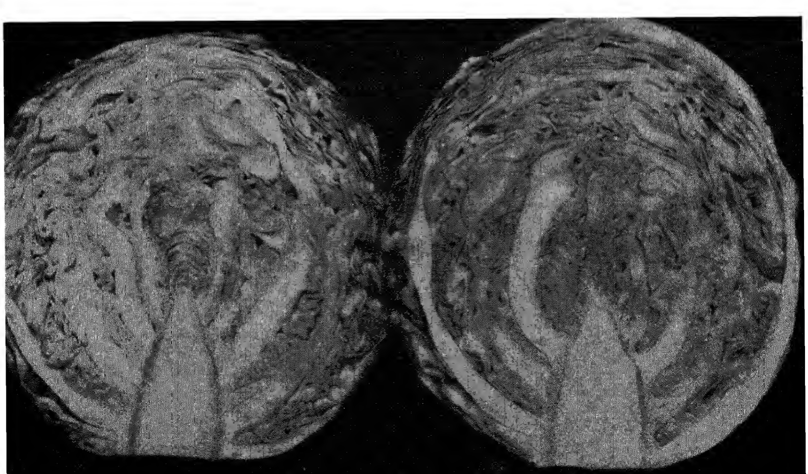

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FIG. 68. Cross section of two heads showing desirable interior characteristics of the Copenhagen type.

Job 5. Controlling Diseases and Insects

DISEASES. The most important cabbage diseases the southern grower has to contend with are black rot, root knot, and in some sections, Yellows.

Black rot, caused by *Bacterium campestre*, appears at any stage of plant growth. It is controlled by treating the seed with bichloride of mercury before planting, using one tablet to one pint of water. The seeds are soaked in this solution for 30 minutes, washed in clear water, and dried before planting.

Root knot is a disease caused by a parasitic eelworm and is discussed on page 218.

Yellows, caused by *Fusarium conglutinans*, while primarily a northern disease, does some damage to cabbage in the upper South. The plants turn yellow soon after transplanting, and the leaves fall and the plants die. If this trouble results, use yellows-resistant varieties which have been developed and are now on the market.

INSECTS. The most destructive insects to cabbage are various kinds of cabbage worms, particularly the green worm, the larvae of the cabbage butterfly, the diamond back, and cabbage looper. Plant lice and the Harlequin bug are serious pests.

Cabbage worms can be controlled with rotenone dust. Rotenone is an extract from Derris or Cube plants. The commercial formula is to use one pound of dust to 3 to 4 pounds of a filler material such as tobacco dust, sulfur, talc, clay dust, or other neutral or slightly acid products. Lime should not be used as a filler.

Plant lice can also be controlled with the rotenone dust, using one pound rotenone dust to 3 parts of the filler.

Harlequin bugs cannot be controlled directly. Dusting the plants with the rotenone and tobacco dust or similar materials will act as a repellent.

Other dust combinations which can be used for most of the eating insects are discussed in Chapter 11.

Cabbage looper (*Autographa brassicae*) is fully discussed on page 142.

Job 6. Harvesting, Processing, and Marketing

HARVESTING. In recent years, since Texas has been making heavy shipments, there is not the rush to ship immature heads as in former years. The plant should be allowed to mature into a firm

white head before harvesting. From two to four green wrapper leaves, unless worm eaten, should be left attached, as southern cabbage is wanted green and fresh. As the heads are cut, they are usually tossed to a man in a wagon or cart, and are hauled to the packing shed. In handling, care should be taken not to bruise the head as this makes it unattractive.

GRADING. The tendency is for better grading of southern cabbage as the market wants a firm, uniform head of high quality. The most desirable sized heads are those averaging from 2 to 5 pounds each, with the preference for the smaller heads. Prevailing grade and size standards and regulations can be obtained from the United States Department of Agriculture upon request.

PACKING. In most sections, the cabbage is hauled from the field to a central packing house, while in some areas the crates are filled in the field or on the headlands. The head should be trimmed so as to leave two or three green outer leaves. The heads should be placed in the crates with the stems out and the heads arranged in orderly layers. They should be packed firmly but not tight enough to cause bruising.

STORING. Very little cabbage is stored in the South. To store spring cabbage for any length of time, it would be necessary to place it in cold storage; and since the crop is bulky and the cold-storage rates are usually high, the tendency has been not to place it in cold storage. However, there are exceptions, and if prices were low and expected prices high, cabbage could be stored to advantage. The storage temperature for this crop is around 35° F.

MARKETING. In the leading cabbage-growing areas of the South, many produce agencies arrange for their own production and marketing. In most cases, however, the produce houses have a local representative or send a representative to make f. o. b. purchases. Some cabbage is shipped on consignment, but this method of marketing is not used now so much as in the past. In many areas a portion of the crop is marketed through various types of co-operatives. This latter method is to be recommended where the organization is large enough to maintain an efficient management.

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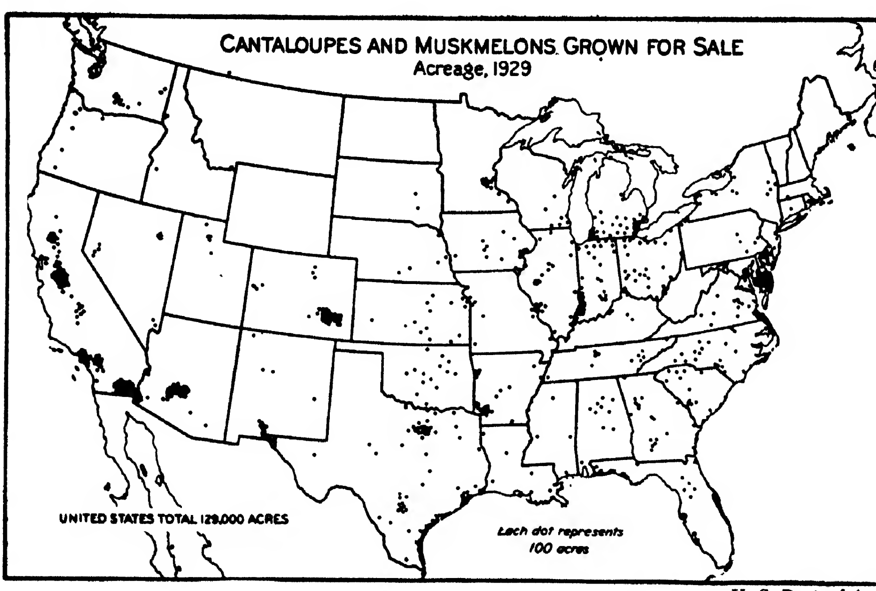
CANTALOUPES (MUSKMELONS)

G. W. WARE, Arkansas Experiment Station, Contributor

CLASSIFICATION, ORIGIN, AND HISTORY. The muskmelon (*Cucumis Melo*) is commonly referred to as cantaloupe in the South and by the trade. It is believed to have originated in India, was mentioned as being grown in Central America in 1516, and was reported in Virginia and New York in 1609 and 1629, respectively.

SCOPE AND IMPORTANCE. Although the cantaloupe has been grown in America since colonial times, its extensive commercial culture did not begin until the development of the Rocky Ford strains about 1890. With improved varieties, rapid transportation, and refrigeration facilities, the cantaloupe industry is now fairly well distributed throughout the United States and ranks as one of the important commercial vegetables. It is available on many of the markets from May to October.



U. S. Dept. of Agr.

FIG. 69. Acreage and distribution of cantaloupes and muskmelons grown for sale.

California is by far the leading state in acreage and is followed by Arizona and Colorado (Fig. 69). The value of the commercial crop in the 26 leading states ranges from $10,000,000 to $22,000,000 annually. Table 25 shows the relative importance of the crop in the South and several of the leading states.

TABLE 25. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF CANTALOUPES IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION[1]	PRICE PER CRATE	FARM VALUE	CARLOT SHIPMENTS[2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Crates	1,000 Crates	Dollars	1,000 Dollars	Cars	By months
Texas . . .	5,577	67	376	.95	274	397	June, July, Aug.
Arkansas . .	2,636	60	157	.80	126	287	July
North Carolina	2,189	72	157	.75	118	135	July
South Carolina	1,701	85	145	.56	79	195	June, July
Georgia . . .	1,636	62	101	.99	100	102	June, July
Oklahoma . .	563	71	40	.80	32	8	July, Aug.
Florida . . .	364	58	21	1.52	32	3	June
Other States							
California . .	53,364	148	7,922	1.16	8,754	10,523	May–Aug.
Arizona . . .	11,043	139	1,532	.92	1,269	3,619	May, June
Colorado . .	7,844	176	1,382	.84	1,167	1,828	Aug., Sept., Oct.
Total (average) for the 23 leading states	118,566	128	15,143	1.04	15,060	18,626	May–Oct.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.
[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

AVERAGE PRODUCTION COSTS. A cost study conducted in South Carolina in 1929, 1931, and 1932 graphically itemizes the cost of producing cantaloupes, giving an average of $42.63 per acre (Fig. 70). This figure will vary from $30 to $60 per acre in different southern commercial sections, depending on the general price level and the influence of local conditions on land rent, labor cost, necessary fertilizers, insect control, irrigation, cost of containers, and other variable factors.

CLIMATIC REQUIREMENTS. An ideal cantaloupe climate includes a fairly long frost-free season with plenty of sunshine and heat, a dry atmosphere, and sufficient soil moisture. The Southwest is particu-

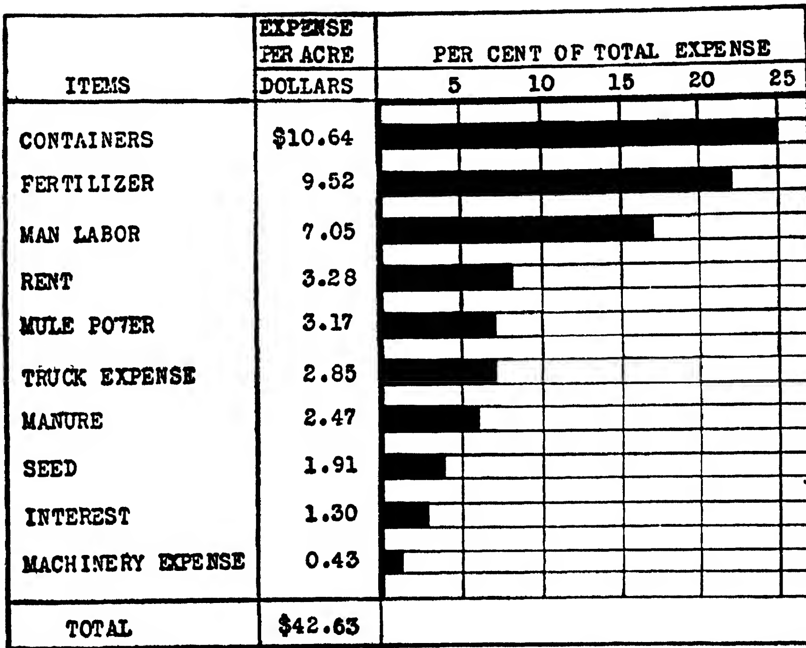


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FIG. 70. Weighted average cost of producting cantaloupes.

larly suited to melon culture, but favorable natural conditions prevail in many other sections of the country, making it possible for skillful farmers to grow the crop advantageously for local markets. Ordinarily, 80 to 100 days of favorable growing weather are required between planting and first harvest.

Job 1. Selecting Varieties and Seed

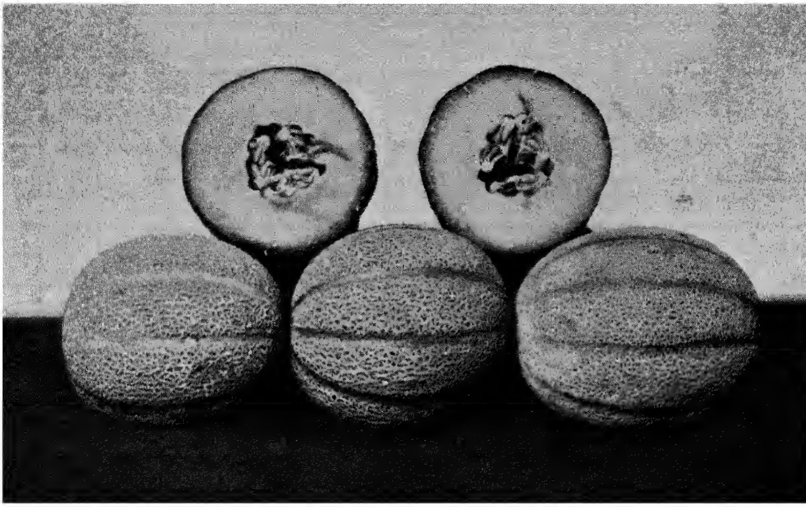
In selecting cantaloupe varieties, the grower should consider market preference, earliness, yield, disease and insect resistance, shipping quality, and other factors which influence profits. The types of cantaloupes grown for shipment consist mainly of heavily netted, medium size, and nearly round specimens of both the green and salmon-fleshed varieties. This type is preferred because of its carrying quality, desirable size and shape, and superior quality when sufficiently ripened on the vine.

VARIETIES. Many varieties are grown for commercial and home use in the South. Hale's Best (Fig. 71), Pollock 10–25, Superfecto, Hearts of Gold, Fordhook, and Emerald Gem are the most important ones. A parallel description of these and other varieties is given in Table 26.

TABLE 26. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF CANTALOUPES

Variety	Chief Use	Season	Fruit			Flesh	
			Size, pounds	Shape	Netting	Thickness	Color
Bender Surprise	home, market, shipping	early mid-season	large, 5–7	globular	very little	thick	bright salmon
Eden Gem	home, shipping	early	medium, 2–2½	slightly oval	very heavy	medium	green-gold lined
Emerald Gem	home, market	early	small, 1½–2	globular	slight	medium	salmon
Fordhook	home	mid-season	medium small, 1½–2½	flattened globe	heavy	thick	salmon
Hale's Best	home, market, shipping	early mid-season	medium to large, 2–4	short oval	heavy	thick	salmon
Hearts of Gold	home, market	late	medium, 2–4	globular	heavy on ribs only	medium	pink salmon
Honey Rock	home, market	early mid-season	medium large, 3–4	oval	medium coarse	thick	salmon
Improved Perfecto (Superfecto)	home, market, shipping	early mid-season	medium, 2–3	short oval	heavy	thick	salmon
Pollock 10–25	home, market, shipping	late mid-season	medium, 2–3	oval	heavy	medium	green, salmon-tinted center
Rocky Ford	home, market, shipping	mid-season	medium, 2–3	short oval	heavy	thick	green, salmon-tinted center
Tip Top	home, market	early mid-season	large, 5–6	globular	heavy	thick	salmon

SECURING SEED. Since the cost of seed is a small item in producing cantaloupes, it is important to obtain the very best quality available. Good seed should be pure, viable, free from pests, and true to a good name. Markets require melons of certain characteristics, and such fruit cannot be grown unless the seed planted came from melons having the desired qualities. A considerable amount of commercial seed is produced in the areas of production, yet large quantities come from the Rocky Ford area of Colorado where climatic conditions and production methods are especially favorable for seed production. It is a good



Landreth Seed Co

FIG 71. Hale's Best is a popular general purpose cantaloupe in the South.

practice to secure seed only from a reliable distributor or producer. The stock number of the original seed should be obtained in order to secure seed of the same parentage for subsequent plantings in the event it proves satisfactory.

Job 2. Preparing the Soil

SOIL PREFERENCES. Cantaloupes are grown on a great variety of soil types, but they thrive best on a well-drained, sandy or silt loam soil. The soil should be fairly fertile, well supplied with organic matter, and free from nematodes and disease. A soil slightly acid or neutral is preferable in cantaloupe production.

PREPARING THE SEEDBED. Thorough plowing to a depth of 5 to 9 inches early enough in the spring to allow proper settling is essential. Seedbed preparation varies greatly in the southern states. In some sections, beds are made 5 to 8 feet wide with one row planted to each bed. It is very desirable to have the beds firm yet thoroughly broken. This condition naturally results if the beds are properly prepared in advance. A common practice in Arkansas and adjacent areas is to flat break the land and lay off narrow beds 18 to 24 inches wide and 5 to 7 feet apart. This is done by making one round with a turning plow. This elevates

the plants for adequate drainage, and the interlying area can be worked toward the bed as the young plants develop.

Job 3. Fertilizing, Manuring, and Liming

Cantaloupe plants grow rapidly and require an abundance of plant nutrients. Unless the soil is naturally fertile, additions of commercial fertilizers or manure or both must be made for satisfactory production.

FERTILIZING. Commercial fertilizers are almost indispensable in large producing areas because of the limited amount of animal manure. Results from several southern states indicate that a complete fertilizer of a 1–2–1 ratio analyzing approximately 4–8–4 or 5–10–5 is commonly used. It is generally applied a few days before planting in a wide strip under the row, rather than broadcast, at the rate of 400 to 1,000 pounds per acre. In addition, many commercial sections use a side dressing of approximately 100 pounds of a quick-acting, nitrogen-carrying fertilizer, a foot from the plants when blooming starts. The amount, kind, time, and method of application vary considerably from state to state.

MANURING. Animal manure is excellent for cantaloupes, but its use is restricted in many commercial sections because of scarcity and cost.

Where less than 2 or 3 tons of well-decayed barnyard manure is used per acre, the greatest benefit can be obtained by applying it directly in the hills prior to planting. Quantities ranging from 4 to 6 tons per acre are usually applied in the rows and bedded on far enough in advance of planting to permit proper decomposition. Larger quantities are usually applied in wide rows or broadcast.

Green manures produced by turning under cover crops have been found to increase materially the yields of subsequent cantaloupe crops. Legume covers are preferable for the purpose, as nitrogen is added in addition to organic matter. Where winter crops are used, they should be turned under early enough to decay thoroughly before planting time.

For best results, the organic content should be maintained either by barnyard manure or green-manure crops.

LIMING. Cantaloupes do not thrive on medium or strongly acid soils. Investigations in Rhode Island and Virginia place the cantaloupe with that group of vegetables which prefer soils ranging from slightly acid to neutral (*p*H 6 to *p*H 7). Tests in Arkansas, North Carolina, and other states have confirmed this classification.

Soil acidity is generally corrected by applying some form of lime to the soil, calcium carbonate (ground limestone) being the most practical form to use. Hydrated lime acts more quickly but the cost is greater. The amount of lime to apply for cantaloupes will depend on the degree of acidity, soil type, and other factors. Knott states that, "It takes roughly about 1,000 pounds of hydrated lime per acre to shift the reaction of a sandy loam soil from *p*H 5 to *p*H 6." In a 4-year experiment conducted under Arkansas conditions on moderately acid soils, 1 ton of limestone more than doubled the yield of cantaloupes (Table 27). The limestone was applied at the beginning of the first year only, and 2-, 3-, and 4-ton quantities gave little increase over the 1-ton application.

TABLE 27. EFFECT OF DIFFERENT AMOUNTS OF GROUND LIMESTONE ON CANTALOUPE PRODUCTION

AMOUNT OF LIMESTONE USED PER ACRE	FOUR-YEAR ACRE AVERAGE IN STANDARD CRATES OF MARKETABLE MELONS	GAIN OVER CHECK
Check — no limestone — no manure	63	—
1 ton limestone + 10 tons manure	181	118
1 ton limestone — no manure	143	80
2 tons limestone — no manure	141	78
3 tons limestone — no manure	150	87
4 tons limestone — no manure	155	92

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Where lime is needed, it is customary to broadcast 1,500 to 2,500 pounds of finely ground limestone per acre and to mix it with the soil thoroughly before planting. It is probably best to apply moderate amounts every 2 or 3 years rather than large quantities every 4 to 6 years. The use of lime is discussed in Chapter 6, and requirements for different soils are given in Table 8, page 65.

Job 4. Planting and Protecting

STARTING PLANTS IN BANDS. Cantaloupes are sometimes started in greenhouses or cold frames in 4- by 4- by 3-inch veneer or paper bands. Four to eight seeds are planted to each band about ½ inch deep in specially prepared pot soil. Planting is done from 10 to 20 days before the plants are to be moved to the field. Melons are difficult to transplant except when very young. Preliminary tests in south Arkansas show that transplanting advances maturity somewhat,

but reduces yields. Transplanting of large commercial areas may be of questionable value under general conditions.

SEEDING IN THE FIELD. Most cantaloupe seed is planted directly in the field, when the danger of frost has passed. The planting date, rate, and method vary somewhat from state to state. In several southern states, including sections of Alabama, Georgia, and South Carolina, eight to ten seeds are planted by hand or hoe in the hill at a depth of $\frac{1}{2}$ to $\frac{3}{4}$ inch. The hills are placed from 2 to 4 feet in rows spaced from $4\frac{1}{2}$ to 7 feet apart. One to 2 pounds of seed are required to plant an acre by this method. In the larger commercial sections of Arkansas, North Carolina, Virginia, and parts of Texas and Florida, the seed is drilled by planters $\frac{1}{2}$ to 1 inch deep, depending on the character and moisture content of the soil. Two to 3 pounds of seed are usually required to drill an acre.

The cantaloupe is a warm-weather plant and little is gained by planting before the soil is sufficiently warm. A soil temperature exceeding 50° F. is necessary to germinate the seed. If it is cooler than 50° F., the seed decays or germinates so slowly that it is likely to be destroyed by pests.

Growers generally take a chance and plant the commercial crop somewhat earlier than the optimum date, in order to obtain the advantage of the early market. Experience shows, however, that little advantage

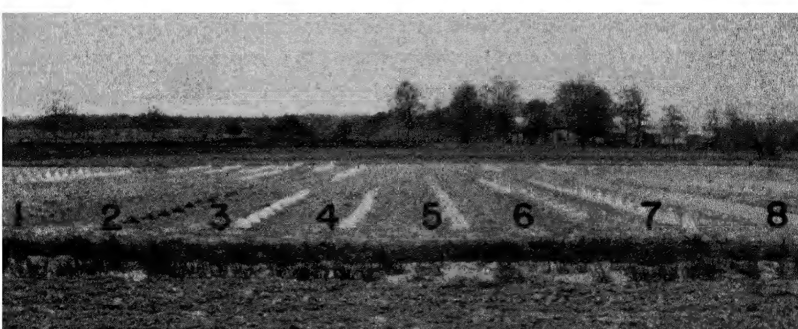

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FIG. 72. Of the various types of plant protectors offered for sale, many are worthless or too expensive. The more standard translucent or transparent cap-type protectors may prove practical under favorable conditions. The different types shown above are: 1, (check) no protection; 2, screen cones; 3, hot-kap; 4, glassene cap; 5, wrapping paper cap; 6, celoglass cylinder; 7, cardboard cones; and 8, continuous paper greenhouse.

is usually gained from extremely early plantings when all hazards are considered.

Planting dates vary from February in the warmer sections of Texas and Florida to late April in the later areas of the South. The average planting date ranges from March 20 to April 10 in most areas.

PROTECTING PLANTS. Plant or frost protectors are used in a limited way for starting cantaloupes in the South. A 3-year test in south Arkansas, in which most types of protectors were used on cantaloupes, indicated that only the translucent or semitransparent paper caps were of any practical value (Fig. 72). Little was gained by advancing the planting date, as the covers afford limited protection from prolonged low temperatures and unfavorable weather. Protectors were found to be satisfactory when placed over seed planted in hills at the regular planting date or a few days earlier. Advantages gained in early plant growth under protection largely disappeared by harvest time, there being only 3 to 4 days' difference in first harvest between protected and unprotected plants.

The benefits resulting from desirable covers include (1) protection from unfavorable weather and pests, (2) higher germination and earlier emergence, (3) larger percentage of earlier melons, and (4) increase in total yield (Table 28).

TABLE 28. COMPARISON OF DEVELOPMENT AND PRODUCTION OF PLANTS STARTED UNDER THE STANDARD HOT-KAP WITH THOSE STARTED IN THE OPEN (THREE-YEAR AVERAGE)

Factor Compared	Method of Starting	
	In open	Under hot-kap
Days from seedling to emergence	10	6
Percentage of final stand	79	93
Green weight of ten 30-day-old plants (grams)	8.7	24.3
Days gained in first bloom	—	5
Days gained in first harvest	—	4
Acre yield of early marketable melons	1,032	1,878
Percentage of total yield as early melons	36	49
Total acre yield of marketable melons	2,854	3,653

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The chief disadvantages of using protectors are (1) cost, (2) difficulty of properly applying, ventilating, and removing, and (3) inability to forecast the weather, which determines their value.

The initial and handling costs of standard hot-kaps averaged about one cent each. This adds $18 per acre where 1,800 protectors are spaced in hills 4 by 6 feet apart. In determining whether or not this additional cost is justified, producers must take into consideration weather, premium for earliness, market demand, and other variable factors beyond their control.

Job 5. Cultivating and Thinning

CULTIVATING. Cultivation of cantaloupes should begin as soon as the young plants break ground. The cantaloupe is a shallow-rooted plant, the roots often extending beyond the vines. Frequent shallow cultivations should be made until the vines interfere. In many sections where the cantaloupes are drilled on narrow ridges, soil is worked toward the ridges at subsequent cultivations until the middle is finally broken out, thus leaving a wide gently sloping bed. Where the hills are carefully checked, cultivation can be given in both directions by means of a weeder or any light cultivator. For the greater part, however, cantaloupes are cultivated in one direction. Vine turning may be necessary during the later cultivations. Thompson states that, "Cultivation after the vines cover a considerable portion of the ground is probably of little, if any, value, unless weed growth is heavy."

IRRIGATING. Cantaloupe plants require an abundance of moisture during the period when the vines are developing most rapidly, and up to the time the melons are practically grown. Great care should be taken, however, to avoid over-watering just before and during the ripening period.

Where furrow irrigation is practiced, the melons are grown on beds and quick applications of water are applied in the furrows as needed. Careful study of soil conditions and weather prospects is necessary to irrigate successfully. This subject is discussed more fully in Chapter 10.

THINNING AND WEEDING. Two or more thinnings are necessary to reduce safely the final stand to the desired number of plants. To begin with, there are considerably more plants than needed. The first crowded plants are removed a few days after emergence when the first true leaves develop. If planted in hills, they are usually thinned to four or five well-distributed plants the first time. Where striped cucumber beetles or other injurious insects are troublesome, the final

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FIG. 73 Cantaloupe field showing good cultural practices The vines are trained parallel with the row to aid cultivation and afford shade for the young fruit.

thinning is delayed until the plants are well established and have formed three or four true leaves. The number of thinnings required to obtain a desirable final stand varies from year to year, depending on the original stand, presence of pests, weather conditions, and local practices. Where the hill method is practiced, two plants are usually left in each hill. When the seed are drilled, single plants are left at intervals varying from 1 to 2 feet, depending on the distance between rows, fertility, and other factors.

Weeding by hand, or hoeing is necessary in addition to cultivating. The process should be repeated when necessary until the vines are well established.

TRAINING AND REMOVING. In most sections vines are trained parallel with the rows to permit close cultivation. In addition, growers claim that the increased shade protects the melons from extreme sunshine and heat (Fig. 73).

Removing a part of the melons from the vine is not commonly practiced, as melons attain the proper size without reducing numbers. However, increased size can be secured by this method.

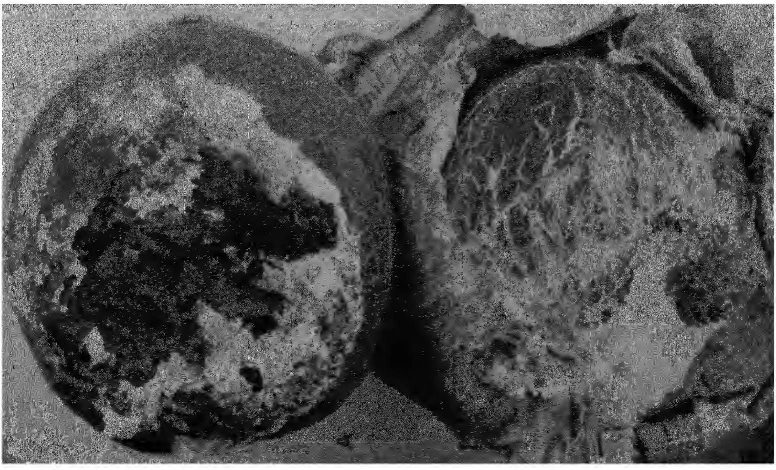
Job 6. Controlling Diseases and Insects

DISEASES. Both the plant and fruit of the cantaloupe are susceptible to diseases, many of which can be prevented by planting on clean land, or reduced by seed treatment, spraying, and dusting.

Bacterial wilt, caused by *Erwinia tracheiphila*, is widely distributed throughout the South, attacking cantaloupes, cucumbers, squash, and pumpkins. The bacterial growth occupies some of the water vessels of the roots, stems, and leaves, and causes the plants to wilt and die. The bacteria causing this disease do not live in the soil but are carried over by the striped cucumber beetle, which spreads the disease from plant to plant. The best control measure for wilt is to keep the foliage covered with a fungicide to kill the bacteria which are excreted by the beetle. Rigid control of the beetle, which is difficult, and prompt removal of diseased plants will materially aid in controlling wilt.

Sclerotium Rot. (See page 134 and Figure 74.)

Anthracnose, commonly called blight, is caused by *Colletotrichum lagenarium* and may appear in epidemic form. All parts of the cantaloupe plant above ground may be affected. The disease is more common on watermelons and cucumbers than on cantaloupes. Small yellowish or water-soaked areas develop on the leaves and fruit. This fungus is transmitted through the soil and by diseased plants and seed. It may be avoided or decreased by crop rotation, sanitation, and by planting



H R Rosen, Ark Exp Sta.

FIG. 74. Cantaloupes rotted during transit by the action of *Sclerotium rolfsii*.

seed which have been soaked for 5 minutes in a solution of one ounce of corrosive sublimate to 7 or 8 gallons of water, and thoroughly rinsed.

Downy mildew, caused by *Plasmopara cubensis*, attacks only the leaves during warm, damp weather. Thorough spraying with a 4–6–50 Bordeaux mixture (in terms of hydrated lime) at weekly or 10-day intervals is recommended.

Root knot (Nematodes), caused by the nematode *Heterodera marioni*, attacks the roots. The galls produced on the roots by the eelworms check plant growth and prevent proper fruit maturity. Considerable damage is done by root knot on sandy soils, and the most practical control measure under field conditions consists of rotating with resistant plants. Since nearly all cultivated grasses and cereals, such as corn, oats, wheat, rye, barley, and sorghum, are resistant, they can be used for approximately two seasons in heavily infested soil with a great reduction in numbers of the parasite. In addition to grasses, Laredo soybeans, Brabham, Victor, and Monetta cowpeas, velvet beans, and peanuts also are resistant.

INSECTS. Growers should be prepared to combat insects which attack all parts of the cantaloupe plant at different stages of growth.

The Striped Cucumber Beetle is a very serious pest in many sections, destroying the young plants as soon as they come up. This beetle and methods for controlling it are fully discussed on page 141.

The Twelve-spotted Cucumber Beetle. (See page 141.)

The melon aphid[1] (*Aphis gossypii*) or louse is a small, green, soft-bodied insect, which obtains its food by sucking plant juices. It feeds on the underside of the leaf, causing it to curl, change color, and die. A solution composed of $\frac{3}{8}$ of a pint of nicotine sulfate (40 per cent nicotine), 3 pounds of yellow laundry or fish-oil soap, and 50 gallons of water has been found effective. It should be applied directly on the lice at necessary intervals. In hot weather, a dust containing 2 per cent nicotine affords satisfactory control.

Pickle and melon worms (*Diaphania* spp.) frequently cause much damage in Georgia, the Carolinas, and other southern states. The adult is a large moth which emerges in the spring. It lays its eggs on the plant, and the young larvae bore into the fruit during the ripening season. Early planting and the use of bush squash, planted as a trap crop, as explained on page 132, are preventive measures.

[1] U. S. Dept. Agr. Farmers' Bull. 1499.

Calif Exp Sta

FIG. 75 A well-planned system of harvesting and grading cantaloupes is essential for success

Job 7. Harvesting, Packing, and Marketing[1]

Good production practices alone do not insure financial success. Much depends on the care and judgment exercised in harvesting, handling, and marketing the cantaloupe crop (Fig. 75).

HARVESTING. The length of time required to reach market, the variety, temperature at harvest time, and the method of shipment determine the stage of maturity at which melons must be harvested. Since edible quality depends on texture, flavor, and sweetness, the stage of maturity is a very important factor.

Proper maturity is difficult to ascertain, as color of skin, stem abscission, netting, and other familiar indications of maturity are not infallible in determining the degree of ripeness. A common guide used in determining the time of picking melons is the ease by which they can be removed from the vines. As a rule, the "full-slip" melon is one which has reached advanced maturity and can be easily removed. The stem separates from the melon, leaving a clean stem cavity. Melons pulled at this stage must be carefully handled and promptly shipped, either under

[1] U S Dept. Agr Farmers' Bulls. 707 and 1468.

refrigeration or to nearby markets. The "half-slip" melon is one which is less mature, requiring more pressure to detach. Upon removal, about one-half of the stem next to the melon remains attached. Most cantaloupes which are shipped to distant markets are pulled at the "half-slip" stage. They should be ready for eating in 36 to 48 hours after reaching market, depending, of course, on shipping and weather conditions. Both the "full-slip" and "half-slip" melons are fully netted; and the background color has changed from a cucumber green to a mottled green and light yellow. In all cases, it is desirable for the melons to remain on the vines until they have reached the greatest degree of maturity which is consistent with the method of handling. Markets have made frequent complaint that many melons are picked too immature for best quality, thereby reducing the price and sale of the product.

GRADING. Melons are graded for uniformity in size and maturity. Although standard grades have been devised by the United States Department of Agriculture, specifications have been altered from time to time. Supply and price determine shipping grades to a large extent. Cracked, bruised, diseased, ill-shaped, soft, ripe, immature, and slick melons are discarded as culls. It usually pays to ship only the best quality melons of uniform size and maturity.

U S Dept Agr

FIG. 76. A standard cantaloupe crate showing the 45-pack.

PACKING. Although types of containers and methods of packing vary considerably in the South, practices have been fairly well standardized in most commercial sections. Crates are primarily used for shipping long distances. The 12- by 12- by 22½-inch standard crate is most popular; but conditions frequently require the 13- by 13- by 23½-inch jumbo crate or the 11- by 11- by 22½-inch pony crate. In addition, two sizes of flat crates are rather extensively used, the 6½- by 16½- by 22½-inch standard flat and the 7½- by 16½- by 22½-inch jumbo flat.

The large markets recognize a pack consisting of 45 melons to the standard 12- by 12- by 22½-inch crate. The 45-pack is made by properly placing in the crate 45 melons, ranging from 4 to 4½ inches in diameter. This pack consists of three layers, each containing three rows of five melons each (Fig. 76). The melons are placed end to end and completely fill the crate. Slightly larger melons are packed 36 to the standard crate, each of the three layers consisting of four melons in three rows. This size constitutes the bulk of the commercial crop in many sections. Melons exceeding 5 inches in diameter are usually packed 27 to a standard crate or 36 to a jumbo crate.

A crate similar to the 32-quart berry crate is used to some extent in Virginia and other sections. Hampers and baskets are used considerably for local markets and short hauls. In recent years, especially during periods of low prices, many cantaloupes have been sold directly to motor trucks. The melons are loaded on the trucks in bulk or in various kinds of containers, both in the field and at packing sheds.

MARKETING. A large quantity of the cantaloupes grown commercially in the South are shipped to northern markets and sold principally by commission merchants. Trucks are seriously competing with railroad transportation in some sections. A part of the southern crop is also marketed locally in towns and cities, and sold directly to customers from roadside markets.

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CELERY

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CLASSIFICATION, ORIGIN, AND HISTORY. Celery (*Apium graveolens* var. *dulce*) belongs to the *Umbellifera* family which includes carrot, parsley, and parsnip. The native habitat of celery extends from Sweden to Egypt and Abyssinia, and in Asia to the Caucasus, Baluchistan, and India. It has also been found growing wild in California and New Zealand. Celery was first mentioned as a cultivated food plant in France in 1623.

SCOPE AND IMPORTANCE. Celery is one of the most popular salad crops in the United States, being exceeded only by lettuce. It was once considered a luxury and was restricted to a short season; but it is now a fairly common item in the diet, and is available practically throughout the year.

The commercial production of celery in the United States increased from 15,863 acres valued at $3,922,844 in 1909, to 20,148 acres valued at $9,462,277 in 1919, and to an average of 33,096 acres valued at $13,502,000 for the 1929–1935 period. California leads in acreage and total production. Florida is a close second and outranks California in total value of the crop. These two states, with New York, Michigan, and New Jersey, produce the bulk of the nation's crop, as shown in Table 29. Florida ranks first in price per crate and carlot shipments, and is exceeded only by New York in yield per acre.

Florida is the only important celery-producing state in the South. The industry is centered in two areas of Florida, namely: The sandy-soil, Sanford-Oviedo section; and the relatively new, muck-soil, Sarasota section. Celery growing around Bradenton, in Manatee County, has practically disappeared. Some celery is being grown on muck soils in the Everglades around Belle Glade.

AVERAGE PRODUCTION COSTS. Celery is a very expensive vegetable to produce and put on the market, a vast amount of labor being required to grow, process, and market the crop. The cost in Florida ranges from $300 to $800 per acre, depending on the amount of

TABLE 29. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF CELERY (MARKET) IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [1]	PRICE PER CRATE	FARM VALUE	CARLOT SHIPMENTS [2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	crates [3]	1,000 crates	Dollars	1,000 dollars	Cars	By months
Florida	6,417	288	1,850	2.12	3,918	8,205	Dec.–June
Other States							
California	9,357	269	2,514	1.48	3,677	7,588	Oct.–July
Michigan	6,037	245	1,479	1.16	1,723	1,086	July–Nov.
New York	5,124	320	1,640	1.13	1,858	3,720	Aug.–Dec.
New Jersey . . .	1,566	209	327	1.46	478	27	July, Nov., Dec.
Total (average) for the 13 leading states.	33,096	274	9,082	1.50	13,502	21,540	June–Dec.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.
[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.
[3] Crates $\frac{4}{5}$ size (New York), crates containing approximately 90 pounds.

fertilizer used, value of land, irrigation requirements, cost of labor, and other variable factors.

CLIMATIC REQUIREMENTS. Celery thrives best where the weather is relatively cool, especially at night, and with a well-distributed rainfall or where irrigation is used. Except in especially favored localities, its culture is limited to fall, winter, and early spring in the South. Production in the North is limited to summer and fall crops and in California it is produced in the fall, winter, and spring.

Job 1. Selecting Varieties and Seed

VARIETIES. In selecting a variety of celery, vigor of growth, resistance to disease, ease of blanching, storing quality, appearance, flavor, and crispness when served are factors to be considered.

There are only a few distinct varieties of celery. Although 50 or more are listed by seedsmen, not more than 12 or 15 are clearly defined. Of this number, four or five of the leading varieties constitute approximately 90 per cent of the commercially grown crop.

The most important standard varieties are Golden Self-blanching, Easy Blanching, Golden Plume (Wonderful), White Plume, Giant

Pascal, Winter Queen, Boston Market, and Emperor. Of these varieties, Golden Plume and Golden Self-blanching and their various strains are by far the most important in Florida.

A brief description of the leading varieties follows:

Golden Self-blanching. Plant of medium height, erect, compact in growth; foliage vigorous, golden green in color; stalk thin, sharp edged, and deeply ribbed; medium early; the most important celery variety.

Golden Plume (Wonderful). Plants medium size, stocky, full hearted, and compact; thick solid stalks; earlier than Golden Self-blanching; a leading Florida variety (Fig. 77).

Francis C Stokes & Co, Inc

FIG. 77 Golden Plume is a leading celery variety in Florida. This specimen is 60 days old from date of planting in an Oviedo, Florida, field.

Easy Blanching. Plants less erect, more vigorous, and darker in color than Golden Self-blanching; stalks thick, solid, and of rich flavor; second early; a good variety for home garden and truckers.

Giant Pascal. Plants medium in height, erect, and compact in growth; foliage dark green in color; ribs broad and shallow; a leading late or winter variety.

SECURING SEED. Much of the celery seed used in the United States is imported from France, but California produces considerable quantities. Celery seed is comparatively expensive, ranging from $1.25 to $2.25 per ounce, but it is good economy to buy the best quality seed from a reputable seed firm.

Job 2. Preparing the Soil

SOIL PREFERENCES. Because of the high nutrient and great water requirements of celery, soil character is a determining factor in celery production. Celery grows best on a fertile muck or sandy-loam

soil, which is loose and friable and which has high water-holding capacity. Celery prefers a moderately acid soil approximating a pH of 6.0.

Suitable celery soils vary considerably in Florida. Near Sanford, a low, "flatwoods," naturally wet, fine sandy soil is used. Drainage is essential, and when accomplished, it serves the dual purpose of drainage and sub-irrigation. Most of the "flatwoods" of Florida are artesian-well areas, since the first 16 to 36 inches of black soil is underlain with an impervious layer of clay.

At Bradenton, most of the celery is grown on a sandy muck, and surface irrigation is practiced. This necessitates ridge planting as contrasted with flat culture in the Sanford area.

PREPARING THE SOIL. One of the determining factors of successful celery production is the preparation of the soil. The very best attention should be given to deep plowing and thorough pulverization. The soil should be plowed deeply to increase the water-holding capacity, since celery, because of its shallow root system, suffers very readily from drought.

Deep plowing followed by numerous and thorough harrowings is usually sufficient. In the South, the land should be plowed far enough in advance to allow ample time to pulverize the soil thoroughly, the exact time depending on the crop previously grown. If a cover crop is used, it should be turned under in time to allow sufficient decomposition prior to setting the plants, and the soil should be harrowed, raked, and smoothed, either by a roller or drag implement.

Job 3. Fertilizing and Manuring

Celery is a heavy feeder and a very poor forager, therefore large quantities of fertilizers are generally applied. When mineral soils are used for growing this crop, manure usually is used in large quantities, especially in the North. Where manure is used, it is advisable to supply some commercial fertilizer, especially some readily available nitrogen, such as nitrate of soda, and also some phosphorus carrier, as superphosphate. In Florida, dependence is placed on commercial fertilizer and soil-improving crops.

Growers do not agree on the best kind of fertilizer for celery. The kind, amount, and method of applying fertilizer vary considerably from section to section and within a single producing area. From 2 to 6 tons of a complete fertilizer analyzing 5–5–5, 6–6–6, 4–8–6, or 6–2–8 are applied per acre on the sandy soils of Florida. Generally, about one-

third of the fertilizer is applied broadcast a few days before planting, and the remainder is applied in three or four applications as top or side dressings.

It does not seem possible, however, that a crop of celery could utilize the nutrients supplied in 4 or 5 tons of a 5–5–5 or 6–6–6 fertilizer. It seems safe to say that from 1 to 2 tons per acre of fertilizer of normal concentration is sufficient under most conditions.

In the intensive production of celery in Virginia, about a ton of 6–6–5 is broadcast several days before transplanting; 1,000 pounds of the same material is applied as top dressings when the transplants begin to make new growth and again when the leaves of the plants begin to touch between the rows (spaced approximately 12 inches apart). This in turn may be followed by two or more 200-pound applications of nitrate of soda applied in solution in the irrigation pipes.

Texas producing areas generally use from 1,000 to 2,000 pounds of a 5–10–5 or a 6–12–6 fertilizer on the growing crop after planting. Fertilizer practices have not been definitely established, however.

Job 4. Preparing the Seedbed and Sowing the Seed

Celery seed is planted either in the open or under protection. It is never planted where the crop is to grow to maturity because of the care necessary to get a stand of good plants.

Soaking seed prior to planting hastens germination and is practiced by growers in many sections, especially for the late crop. A common method is to moisten the seed in a receptacle and put in a warm place for several days until the sprouts begin to appear. Another method used by some growers is to place the seed between folds of cloth, which are kept moist.

When the seed is sown in outdoor beds, and the plants are taken directly from the field, it is advisable to sow ½ pound for each acre to be planted. When the plants are grown in the greenhouse and transplanted prior to setting in the field, ¼ pound of seed is sufficient for one acre planted in rows 3 feet apart.

Celery seed is planted shallow, not exceeding ½ inch in depth. It should be covered with pulverized soil and sufficiently wet down.

In Florida, open seedbeds are prepared in the early part of July. After the ground has been thoroughly conditioned, the beds are made by making shallow 2-foot trenches every 6 feet apart, leaving 4 feet for the slightly raised beds (Fig. 78). Seed is sown in drills across the beds which are covered with burlap sacks until the seed sprouts. Shade is

provided when the seedlings emerge, by stretching light muslin over triangular supports placed on the beds at intervals of 12 feet. These supports are held in place by three wires which also act as anchors for the muslin, which is pinned with clothespins. On one side of the bed a fourth wire is stretched at a height so that one side of the muslin may be raised to permit better aeration and hardening of the plants. Later, as the weather cools, these covers are removed entirely. Spraying with 4–6–50 liquid Bordeaux (in terms of hydrated lime) begins as the leaves

Palmer Farms, Sarasota, Fla

FIG 78 Celery plants are produced in the open in Florida. Seed is planted in drills crosswise of the slightly elevated 4-foot rows

appear and continues at 7- to 10-day intervals until the plants mature, in order to control early and late blight.

Planting methods are somewhat similar in Texas. Seed is sown in May and June on raised beds 3 feet wide, with ditches 1 foot deep and 1½ feet wide. Seed is sown broadcast with a pepper shaker, and kept covered with wet burlap until emergence. The surface is constantly kept wet until the seedlings emerge, then the burlap is raised 4 to 6 inches and left for shade. The ditches or trenches are kept full of water until the seedlings are well established.

In Virginia, seed is sown in 3-inch rows in hotbeds and greenhouses during December and January. The seedlings, when 4 or 5 inches high,

are transplanted to their permanent locations in cold frames in late March; and are grown to maturity under intensive conditions.

Job 5. Setting and Applying Water

SETTING PLANTS. The plant bed should be watered a few hours before taking up the plants to set in the field. It is desirable to set the plants when the soil is moist and the air rather humid.

Plants are generally removed from the beds and set in the field when they have attained a height of 3 to 4 inches and a crown-diameter of $\frac{1}{4}$ to $\frac{3}{8}$ inches. The plants should be set at the proper depth, not deep enough to cover the growing point, and the soil should be firmly pressed around the roots.

Planting distances and methods vary in different parts of the country. The number of plants needed for an acre varies according to the distance between the rows and between the plants within the row. The distance between rows varies from 30 to 42 inches and the distance between plants in the row from 3 to 6 inches. Accordingly, 26,000 to 60,000 plants are required to set an acre.

In Florida, planting starts in early fall and continues until February. Plants are generally set $3\frac{1}{2}$ inches apart in rows spaced 30 inches apart. In some sections, double rows of plants are set 6 inches apart each way on the bed. The plants are set by hand. A grower usually employs a crew of 10 or more workers and pays an agreed price for setting plants by the thousand. Some of the workers walk along and drop the plants while others crawl on the ground and do the setting. The plants are watered soon after setting by pouring water in slight trenches made by the side of the plants or by flooding. This method, with some modifications, prevails in other sections of the South.

IRRIGATING. Celery is a moisture-loving plant, and unless the soil on which the crop is grown is of a natural moist character, the application of water is necessary. Three systems of irrigation are in general use: (1) The underground or sub-irrigation method, (2) the furrow or surface system, and (3) the overhead-sprinkler system. Of these, the sub-irrigation system is principally used in Florida and surface irrigation in Texas. The overhead-sprinkler system can be used, but it is more expensive to construct and operate, and does not provide drainage during wet weather. The sub-irrigation system gives the grower almost complete control of the moisture supply, as it is used both for irrigation and drainage.

American Cyanamid Co

FIG. 79 Celery requires heavy fertilization and clean cultivation.

Job 6. Cultivating and Blanching

CULTIVATING. Good clean cultivation throughout the growing season is important, since weeds are troublesome on most soils used for celery growing (Fig. 79). The celery plant grows slowly and is soon injured by weeds. Celery responded more to cultivation for the purpose of maintaining a soil mulch than any of the other crops grown in the cultivation experiment at Ithaca, New York. Celery roots do not have so much spread as most other vegetables, and it is thought that because of this, less moisture is intercepted by celery roots than by roots of cabbage, for example. In all cultivation the surface soil should be left as level as possible. Therefore, it is desirable to use small-tooth cultivators. Shallow cultivation is desirable at all times, especially near the plants, as many of the roots grow near the surface and within 6 to 12 inches of the row.

BLANCHING. The blanching of celery results in the loss of green coloring, reduces the strong flavor, and makes the leaf stalks crisp and tender. Blanching is accomplished by excluding the light from the leaf stalks while the plants are still growing. Several methods are employed, including the use of paper, boards, and soil. Paper and boards are used almost exclusively for blanching celery in the South, since it is not safe to use soil when the weather is warm.

For the self-blanching varieties, celery is generally blanched by means of a specially prepared paper about 10 or 12 inches wide. The paper is

placed on edge close to the plants and is held in place by wicket-shaped wires pushed into the soil at regular intervals.

Boards are used in many regions where lumber is cheap. The boards, usually one inch thick, 10 to 12 inches wide, and 14 to 16 feet long, are placed on edge on either side of the row, close to the celery, and are held in place by wires bent in the form of double hooks 6 to 8 inches long. These wires are hooked over the upper edges of the boards at proper intervals. Soil is then banked evenly and firmly along the lower edge of the boards to hold them in place and to close any openings.

Banking with soil is the most economical method, but has disadvantages. The soil is worked up to the plants gradually to avoid getting into the center of the plant. The wings of a hiller are adjustable so that the soil can be pushed to any desired height.

The length of time required for blanching depends on the variety and the growing conditions. The so-called self-blanching varieties such as Golden Self-blanching and Easy Blanching require much less time than the green varieties such as Giant Pascal, Winter Queen, and Emperor. When celery is growing rapidly, it will blanch in less time than when growth is slow. In summer, 10 to 16 days are usually required, while more time is required in the fall.

Job 7. Controlling Diseases and Insects

DISEASES. Celery is subject to many diseases which, if not controlled, may cause serious losses. Some of these can be avoided by cultural practices and field sanitation, while others are controlled by spraying.

Pink rot is caused by the fungus *Sclerotinia sclerotiorum.* It is one of the most destructive diseases of celery, especially during years when climatic conditions are favorable for the development of the fungus. Pink rot causes a damping-off of young plants in the seedbed, a light pinkish rot of stalks in the field, and a watery soft rot in transit. It is prevalent in Florida and in northern celery-growing areas. Pink rot can be controlled partially by spraying with a 4–6–50 Bordeaux liquid mixture (in terms of hydrated lime). Field sanitation and careful washing and packing are effective in preventing the disease in transit.

Early blight, caused by *Cercospora apii,* first occurs in the seedbed. It causes great damage there and is transmitted to the field by the young seedlings. It appears first as small, circular, yellowish-brown spots on the leaves; these spots enlarge and eventually assume a grayish appearance. Early spraying with a 4–6–50 Bordeaux mixture (in terms of

hydrated lime) is usually sufficient to control early blight, but it is profitable to continue spraying, in order to catch the late blight.

Late blight, *Septoria petroselini* var. *apii*, attacks the plants only in the cooler part of the growing season. It is very similar to early blight, being distinguished only by the smaller, more oval spots speckled with black dots, which occur on the petioles. It attacks all parts of the plant above the ground. The control is the same as for early blight.

Root knot. (See page 218.)

Cracked stem. This so-called disease is very destructive in Florida, and has caused considerable loss to celery growers in other regions. It is characterized by crosswise cracks in the outer layers of the petioles. According to Purvis and Ruprecht, this disease first manifests itself by a brownish mottling of the leaf, usually appearing first along the margins. This mottling is accompanied by a brittleness of the petiole and is soon followed by the appearance of crosswise cracks. The tissues surrounding the cracks turn brown. The roots also turn brown and the laterals die.

Results of experiments conducted in Florida indicate that an application of 10 pounds of borax to the acre is effective in preventing the development of cracked stem and in increasing the yield and quality of celery. Borax in quantities as low as 30 pounds to the acre, however, was found to be distinctly harmful.

Black heart often causes greater losses than any other disease. It is non-parasitic, being caused by improper water relations and other factors, such as age of plants, soil conditions, and variety of celery grown. The only control known is to follow a careful plan of culture, giving special attention to water supply.

PREMATURE SEEDING OR BOLTING. Premature seeding is not a disease, but it results in loss of a portion of the crop. In some seasons premature seeding is very serious in Florida and may result in almost total loss of a planting, but it seldom happens that all of the plantings are affected.

Thompson has shown that the temperature under which the plants are grown, particularly during the early stages, is a very important factor in premature seeding. If the temperature averages between 40° and 50° F. for 2 weeks or longer, or between 50° and 60° F. for a month or two while the plants are small, they are likely to develop seed stalks. After the plants have been subjected to the temperatures mentioned, any treatment that stimulates growth, such as applying nitrate of soda, tends to hasten seed-stalk development. Contrary to a fairly common belief,

freezing does not cause seeding, but rather tends to delay it. Likewise checking growth by other means, such as withholding water, delays seeding and may prevent it entirely. Relatively high temperatures (averaging 70° F.) may prevent seeding even after the plants have been subjected to the relatively low growing temperatures mentioned above.

Heredity is important in premature seeding. Some strains are much more subject to bolting than others, and it is possible to develop non-bolting strains. In fact, at least one such strain has been developed. So-called non-bolting strains require a longer exposure to relatively cool temperatures for seed-stalk development than do bolting strains.

INSECTS. The principal celery insects are leaf-tiers, loopers, cutworms, and plant lice.

The celery leaf-tier (*Phlyctaenia rubigalis*) is one of the most harmful insect pests. It is a small brown moth, less than ½ inch long, with faint lines on the wings. When at rest, the wings form a triangle. It has two rows of small black spots on the under side of the cream-colored abdomen. The larvae of the leaf-tier feed on the leaves and cause serious damage when large numbers are present.

Control is obtained by practicing clean culture, removal of crop refuse, promotion of natural bird life, and by means of dusting with fresh pyrethrum dust. The dust must reach all parts of the plants to be effective.

The celery looper (*Autographa falcifera*), similar to the cabbage looper, is present in the South but not in great numbers. Natural parasitic enemies of this insect tend to keep it down, but in some cases control methods similar to those used for the leaf-tier are necessary.

Plant lice and cutworms sometimes appear in damaging numbers. Control methods are given on pages 135 and 137 respectively.

Job 8. Harvesting, Processing, and Marketing

HARVESTING. Celery may be harvested as soon as it attains proper size and is properly blanched. Early celery often is harvested before the plants are full grown in order to take advantage of a high price. The celery plants are cut off below the surface of the ground with a sharp knife, with a spade, or with special large-scale implements. The trimmers follow the cutters, lift the stalks and strip off the outer leaves. If the crop is shipped in the rough (without washing or bunching), it is packed into the crates without further preparation. During hot weather the celery should be taken from the field as soon as possible after it is removed from the row, as exposure to sun and wind causes plants to wilt.

WASHING AND BUNCHING. Celery is shipped in both washed and unwashed conditions. When washed before shipping, the washing is done at the packing house by plunging the celery in tanks of water or by spraying water under pressure against the stalks as they pass along on an endless belt. If the celery is shipped without washing, it is usually washed after it reaches the terminal market.

Most, if not all, of the celery shipped from Florida is packed without bunching. It may be bunched for the retail trade in the terminal market and the bunches may vary in size from two to three stalks to a dozen or more stalks to the bunch. When bunched a dozen or more to a bunch, the bunches are tied tightly with colored tape made for the purpose, using two ties, one near the butts and the other near the upper end of the petiole. After being tied, the bunches are trimmed and usually rinsed in clean water, then allowed to drain before packing in the crates.

GRADING AND PACKING. Celery when shipped in the rough may be graded into two grades, but usually is not graded very carefully. Washed celery usually is graded into two or more grades, the number depending on market demand and quality of the product.

The United States Bureau of Agricultural Economics will supply prevailing grade requirements for rough and washed celery.

Celery, when shipped in the rough, is packed in crates in the field without any preparation except to strip off the damaged and discolored leaves. In Florida, much of the celery is washed before packing, but is packed without bunching. Washed celery is often bunched before it is packed in the crate, and the bunches are wrapped or the crates are lined with paper. The paper prevents rapid evaporation from the surface of the celery and protects it from dirt.

Precooling of celery by means of cold water is practiced in Florida. The packed crates of celery are sprayed and are then put in the precooling tanks where they are kept for about 30 minutes. While the celery is in the precooling room, water at a temperature of 33° F. is sprayed over it. From the precooling room, the crates of celery are taken out and passed down a chute to refrigerator cars.

Various types and sizes of celery crates are used for packing celery for market. The common crate used in Florida ($\frac{2}{3}$ Florida celery crate) is light, well ventilated, and measures 10 by 20 by 22 or 24 inches on the inside.

STORING. Celery grown in the South is not stored to any great extent, but some of that grown in Florida frequently is stored for short

periods after it reaches northern markets. Such celery can be kept for a period of four or five weeks in cold storage where the temperature is kept at 32° F. and at high humidity. It would be possible to hold celery in storage in Florida to tide over periods of market gluts and to extend the market in the spring. Under such conditions, it would be desirable to pack the celery in crates in the field and to haul it to the storage house immediately without having it washed.

In the cooler sections of the South, where celery is grown in late summer and fall, it may be kept for several weeks by trenching it in the garden.

SHIPPING AND MARKETING. Most of the Florida celery is shipped in refrigerator cars to northern markets. Cars are loaded with approximately 350 crates. Marketing is done in some localities through co-operative associations, but in many cases the individual grower consigns his shipment to a commission merchant. The crop is also sold in the field, trucks playing a more important part in marketing.

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CORN (SWEET)

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CLASSIFICATION, ORIGIN, AND HISTORY. Sweet corn (*Zea Mays* var. *rugosa*) is a member of the grass family and a native of America. It is a comparatively modern vegetable crop. History records that the colonists began to grow the plant about 1780.

SCOPE AND IMPORTANCE. At the present time, sweet corn is grown widely in the United States and Canada. It is grown for home use, for local markets, for shipment to distant markets, and for canning. By far the greater quantity of sweet corn consumed is canned, but the acreage given over to the production of the crop for long-distance shipment has increased rapidly within recent years. Total acreage, production, yield, and value of sweet corn for canning and market are shown in Table 3, page 5. Principal states supplying distant markets are listed in Table 30.

Table 30. Carlot Shipments of Sweet Corn from Southern States, 1933–1935

State	Shipping Season	Year		
		1933	1934	1935
Alabama	May to June	298	466	643
Texas	May to June	654	266	191
Florida	April to June	81	158	236
North Carolina	June to August	67	90	115
Louisiana	May to June	28	65	74
Georgia	May to June	35	59	18
South Carolina	May to June	13	22	50
Arkansas	June to July	9	18	38
Virginia (Norfolk Section)	July to August	27	11	14

AVERAGE PRODUCTION COSTS. Data on the cost of producing an acre of sweet corn for the cannery in north-central Maryland show that the most important items in the cost of production were manure, soil preparation, and harvesting; that the minor items were

seed, machinery, and lime; and that the intermediate items were fertilizers and cultivation. The 3-year average acre cost for growing and harvesting totaled $33. This figure may be somewhat lower under average southern conditions.

CLIMATIC REQUIREMENTS. Principal climatic factors are (1) temperature and (2) the moisture supply. The temperature has a marked effect on the growth of sweet corn. In general, the higher the temperature between 40° and 90° F. the greater is the rate of growth and the shorter is the time necessary for the plant to attain a particular stage of maturity. Data presented in Table 31 obtained with Stowell's Evergreen grown at the Maryland Agricultural Experiment Station illustrate the effect of temperature.

TABLE 31. CALCULATED RATE OF SWEET CORN RIPENING FOR MEAN TEMPERATURES, 60° TO 80° F.[1]

AVERAGE OF DAILY MEAN (DEGREES F.)	TIME REQUIRED TO PASS FROM PRE-MILK TO BEST CANNING STAGE[2] (DAYS)	TIME REMAINED IN CANNING STAGE (DAYS)
60	14.5	5.0
65	12.0	4.0
70	10.0	3.0
75	8.0	3.0
80	7.0	2.0
85	5.5	1.5

[1] Appleman, C. O.: *Forecasting the Date and Duration of the Best Canning Stage in Sweet Corn*, Md. Agr. Exp. Sta. Bull. 254, 1923.

[2] The juice of the kernel is clear and watery at the pre-milk stage and milky at the canning stage.

Fairly uniform distribution of rainfall is necessary for good growth and high yields. If soil moisture is low when the weather is hot, the plant does not receive sufficient moisture for growth; the manufacture of food declines, and yields are low.

Job 1. Selecting Varieties and Seed

VARIETIES. In general, two types of table corn are grown: (1) Certain strains and varieties of field corn, and (2) true sweet corn. Examples of the former are Adams Early, Mexican June, and Trucker's Favorite. Examples of the latter are Golden Bantam, Country Gentleman, and Stowell's Evergreen.

The variety should be productive and should produce high quality ears which are relatively free from damage by the corn ear worm, and, in addition, the kernels should be tender and sweet.

Another important factor is tenderness of the pericarp (the skin of the kernel), and varieties differ in this respect. Tests indicate that Honey June and Surecropper Sugar possess tougher pericarps than Golden Bantam, Stowell's Evergreen, and Trucker's Favorite.

Experiment stations have tested numerous varieties to determine their relative susceptibility to the corn ear worm. Certain results obtained at Winter Haven, Texas, and at Clemson College, South Carolina, show that Honey June has a well-developed husk at the tip of the ear and is highly resistant to the corn ear worm as compared with Stowell's Evergreen and Country Gentleman (Fig. 80). These and other prominent southern varieties are described in Table 32.

TABLE 32. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF SWEET AND ROASTING EAR CORNS

Variety	Type	Season	Stalk Height, Feet	Ear		Number of Rows	Resistance to Corn Ear Worm
				Color	Length, inches		
Country Gentleman	sweet	mid-season	5–6	white	6–7	irregular	medium
Extra Early Adams	field	early	4–5	white	5–7	12	medium
Golden Bantam	sweet	early	3–4	yellow	4–6	8–14	poor
Honey June	semisweet	late mid-season	7–8	white	7–9	12–16	very good
Mexican June	field	late	6–8	white and blue	7–9	14	very good
Stowell's Evergreen	sweet	mid-season	6–7	white	7–9	12–16	poor
Surecropper Sugar	semisweet	late mid-season	$6\frac{1}{2}$–$7\frac{1}{2}$	white	6–8	10–14	medium
Trucker's Favorite	field	late mid-season	6–7	white	7–8	12–16	medium
Whipple's Yellow	sweet	early mid-season	6–7	yellow	6–7	10–14	poor

SECURING SEED. Plants raised for seed must be isolated from plants of other varieties or strains to prevent cross-pollination. Isolation from any particular variety is usually secured by raising the

plants 750 to 1,000 feet from and preferably on the windward side of any other variety. If pollen of field corn has fertilized any of the sweet corn, the kernels can be detected readily.

Because of its greater sugar and dextrin content, sweet corn seed dries out more slowly and absorbs moisture more readily than field corn, hence rapid drying of the seed ears and protection from moisture in the air while they are stored is necessary. Drying is facilitated by removing the husks from ears immediately after they are harvested and providing for the circulation of air around each ear. This can be done by sticking the butts onto wire hooks, stringing the ears together with twine or placing them in slatted crates or on shelves. Protection from moisture in the air is usually secured by storing seed in heavy paper bags with the tops sealed, in glass and metal jars tightly sealed, or in metal cans. To protect the seed from weevils or moths, it should be mixed with paradichlorobenzene or flakes of naphthalene.

Texas Exp Sta.

FIG. 80. Ears of Honey June, left; Stowell's Evergreen, center; and Country Gentlemen, right. The resistance of the Honey June (left) to severe ear worm damage is due to the larger, heavier shucks.

The development of improved strains and varieties is a highly specialized business. It requires keen observation, close attention to details, and a knowledge of types and varieties and of the principles of plant breeding and methods of pollination. For these reasons, the average grower should obtain his seed from a seedsman who has specialized in this work.

Within the past few years, certain seedsmen have developed varietal inbred crosses of sweet corn. Tests have shown that such inbreds out-

yielded the parent variety from 20 to 50 per cent and were generally more resistant to diseases and ripened more uniformly.

Job 2. Preparing Soil, Fertilizing, and Manuring

PREPARING THE SOIL. Sweet corn is grown on a wide variety of soil types. Growers for the early market usually plant on well-drained, sandy loams, while those for the late market or for the cannery usually select silt or clay loams or well-drained bottom land.

Soil preparation consists of plowing, harrowing, bedding, applying fertilizer, and rebedding. Usually the rows are 3 to 4 feet apart. Fertilizer is applied in furrows and mixed with the soil before the land is rebedded. If well-rotted manure is used, it should be applied broadcast on the plowed land and thoroughly disked into the soil. If coarse manure is used, it should be plowed under 3 or 4 weeks before planting time.

FERTILIZING AND MANURING. The kind and amount of fertilizer that should be applied depends on the fertility of soil used. The Texas Agricultural Experiment Station states that manure applied at rates varying from 8 to 10 tons per acre is most satisfactory for Texas, and that, if manure is unavailable, a 4–8–4 fertilizer should be applied at rates varying from 300 to 500 pounds per acre. The South Carolina Station recommends a 4–8–4 or 4–12–4 mixture applied at rates varying from 400 to 800 pounds per acre. Undoubtedly the best plan is to follow the recommendations of your state agricultural experiment station.

Recent tests with field corn have shown that commercial fertilizers applied in 1-inch bands about 2 inches from and on the side of the seed produce greater yields than that applied under the seed. Since the root system of sweet corn is similar to that of field corn, sweet corn should respond in much the same way as field corn. As is the case with other vegetable crops, commercial fertilizer should never come in contact with the seed.

Job 3. Planting

TREATING SEED. Sweet corn seed is more susceptible than field corn seed to the rot-producing fungi in the soil. This is especially true if the seed is planted when the soil is cold and wet. Investigations have shown that treating the seed with Semesan, Jr., a commercial organic mercury dust, effectively protects it against rot-producing fungi. Semesan, Jr. can be purchased at most seed and hardware stores, and the directions should be followed closely.

Size of seed influences earliness and yield of sweet corn. Experiments at the Indiana Agricultural Experiment Station have shown that plants of the same variety grown from large kernels tassel and produce ears about 5 days earlier than those grown from small kernels. This is particularly important from the standpoint of the market gardener and the canner.

PLANTING DATES. The seed for the early crop is usually planted just before or immediately after the average date of the last killing frost. However, market and home gardeners frequently take a chance on the frost. In this case, usually two or three plantings at intervals of 5 to 10 days are made.

To secure a continuous supply of sweet corn throughout the growing season, two systems may be used: (1) The same variety may be planted at intervals of 10 days or 2 weeks, or (2) early, mid-season, and late varieties may be planted at the same time. In the South, the latter method is probably more advantageous than the former.

The time of planting the first sweet corn varies with the locality. In general, the approximate first planting date in various regions of the South is given in Table 33.

TABLE 33. FIRST PLANTING PERIOD OF VARIOUS REGIONS

REGION	PLANTING PERIOD
South Florida	Feb. 1 to Feb. 15
South Texas, South Louisiana, South Mississippi, South Alabama, and Northern Florida	Feb. 15 to Mar. 1
Central Texas, Central Louisiana, Central Mississippi, Central Alabama, and Southern Georgia	Mar. 1 to Mar. 15
South Oklahoma, South and Central Arkansas, North Texas, North Louisiana, North Mississippi, North Alabama, Central Georgia, South Carolina (lower), and Coastal North Carolina	Mar. 15 to Apr. 1
North Oklahoma, North Arkansas, Tennessee, Upper South Carolina, Central North Carolina, and Southern Kentucky	Apr. 1 to Apr. 15

PLANTING METHODS. Seed is planted by hand, or by hand-operated or horse-drawn planters. Hand planting requires the making of furrows and dropping the seeds in the furrow, while machine planters make the furrows, drop and cover the seed in one operation. Cheap and effective machines are on the market. In general, market gardeners or growers of small acreages use hand machines while canners or growers of large acreages use horse-drawn machines.

PLANTING RATES. Sweet corn is planted in rows varying from 2½ to 4 feet apart, and spaced from 12 to 24 inches in the drill. The rate of seeding depends on (1) the time of planting, (2) the spacing, and (3) the variety. Ordinarily, the earlier the seed is planted or the colder the soil, the greater is the rate of seeding. As a rule, field corn varieties require lesser rates of seeding than the true sweet corn varieties. This is particularly true if the weather is cold and wet at the time seeding is made. Generally, 8 to 14 pounds of seed are required per acre.

Job 4. Cultivating and Suckering

CULTIVATING. The primary purpose of cultivation is to control weeds, and a secondary purpose is to break the crust of self-crusting, usually heavy, soils. In general, shallow cultivation should be practiced. To avoid the necessity of deep cultivation, weeds should be destroyed when they are small. When the weather is hot and dry, the moist soil should never be exposed to dry air, as the moisture evaporates and is lost to the plant.

Certain experiments with field corn grown on heavy soils have shown that shallow cultivation increased yields even in the absence of weeds. Presumably, the breaking of the crust increased aeration of the soil and enabled the roots to obtain the necessary supplies of oxygen.

Under average conditions, cultivation may be outlined as follows: (1) The first cultivation should be relatively deep to loosen the soil and to permit lateral root growth, (2) succeeding cultivations should be relatively shallow and done with the scraper types of cultivators in preference to the toothed types, since they do not cultivate deeply and injure the feeding roots just beneath the surface, and, finally, (3) when the main stem is about one-half grown, unless weeds are prevalent or the soil crusts badly after heavy rains, cultivation should cease.

SUCKERING. Suckering consists of removing the side shoots or tillers from the base of the plant. In the early days of sweet corn production, this practice was very common. Growers believed that suckering produced greater early and total yields and larger ears than did non-suckering. To test the effect of suckering on growth and yield, experiments were conducted at Ithaca, New York, from 1920 to 1925, and on Long Island, New York, from 1923 to 1928. In the Ithaca experiments the Golden Bantam and Stowell's Evergreen varieties were grown on well-drained sandy loam. In the Long Island experiments, the Golden Bantam, Stowell's Evergreen, and Long Island Beauty varieties

were grown on a silt loam. The Golden Bantam produces a large number of suckers and the Stowell's Evergreen produces a relatively small number. Data from the experiments at Ithaca, New York, show that suckering decreased the total yield and failed to increase appreciably the yield of the first harvest and the size of the ear. In addition, suckering markedly decreased the yield of the stover. Results obtained in the Long Island experiments were similar. Thompson states that, since suckering failed to increase appreciably the size of the ear and decreased the total yield of ears and stover and since the practice costs from $3 to $6 per acre, suckering, at least under the conditions under which the experiments were conducted, seems to be unjustified. In other words, the practice under average conditions cannot be expected to be profitable. It is recognized, however, that results obtained in New York may not apply in the South. This being the case, Thompson states that the only way in which a farmer can determine the effect of suckering is to make tests on his own farm for several seasons.

Job 5. Controlling Diseases and Insects

DISEASES. The principal diseases are bacterial wilt and corn smut.

Bacterial wilt, caused by the bacterium *Phytomonas stewarti*, develops inside the water-conducting tubes and produces wilting about the time the plants silk. The bacteria are carried over in the bodies of the corn flea beetles and in the seed. Cucumber beetles and flea beetles are known to spread the parasite from infected stalks to healthy non-infected stalks. The only reliable control measure is the use of resistant varieties, a number of which are now on the market. They should be tested on a small scale before they are planted extensively.

Corn smut, caused by the fungus *Ustilago zeae*, produces puffed out membranous growths on the ears and stems. On the inside of these membranes are compact masses of black spores which are liberated when the membranes break open. Control measures consist of (1) rotating crops and (2) practicing field sanitation. Manure containing diseased stalks should not be used on land planted to sweet corn. The development of resistant varieties appears to be a promising method of control.

INSECTS. The principal insects are corn ear worm, the larger corn stalk borer, and the European corn borer.

The corn ear worm. (See discussion and Figure 49, page 138.)

The larger corn stalk borer (*Diatraea crambidoides*) is the larva of a night-flying moth. The adult lays eggs on all parts of the plant and

the eggs hatch and the larvae bore into the stem. No specific control measures are used, but field crop sanitation is recommended.

The European corn borer (*Pyrausta nubilalis*) is also the larva of a night-flying moth. Eggs are laid on the stems and the larvae bore through the stems and thus enter the ear from within. Control measures include (1) plowing in the fall, and (2) ensiling the fodder immediately after the ears are harvested. This pest is not present in states south of Virginia. In many states in the North, scientists are endeavoring to develop resistant varieties.

Job 6. Harvesting and Grading

HARVESTING. When the kernels are young and small, the juice is clear and watery, and the corn is said to be in the pre-milk stage. As they become larger, more plump, and older, the juice becomes milky, and this is known as the milk stage. In a relatively short time the kernels pass from the milk stage to the dough stage. At the pre-milk stage, the kernels are fairly sweet, but they are small and generally lack plumpness. At the milk stage they are also sweet, but they have attained full size and plumpness, while at the dough stage, most of the sugars have changed to starch. Obviously, ears should be harvested when the kernels are in the milk stage.

Experienced growers do not press the juice from the kernels to determine when they are in the milk stage. This would require partial stripping of the husks, which is objectionable. With many varieties growers have found that when the silks first become brown and the ears feel plump they are ready to be picked.

TABLE 34. LOSS OF SUGAR FROM STOWELL'S EVERGREEN SWEET CORN STORED FOR 24 HOURS[1]

TEMPERATURE (DEGREES F.)	PER CENT SUGARS		
	Start of storage	End of storage	Loss
32	5.91	5.43	0.48
50	5.83	4.83	1.00
68	6.17	4.59	1.58
86	5.34	2.65	2.69
104	6.72	3.64	3.08

[1] Appleman, C. O., and Arthur, J. M.: *Carbohydrate Metabolism in Sweet Corn in Storage at Different Temperatures*, Jour. Agr. Res. 17: 137–152, 1917.

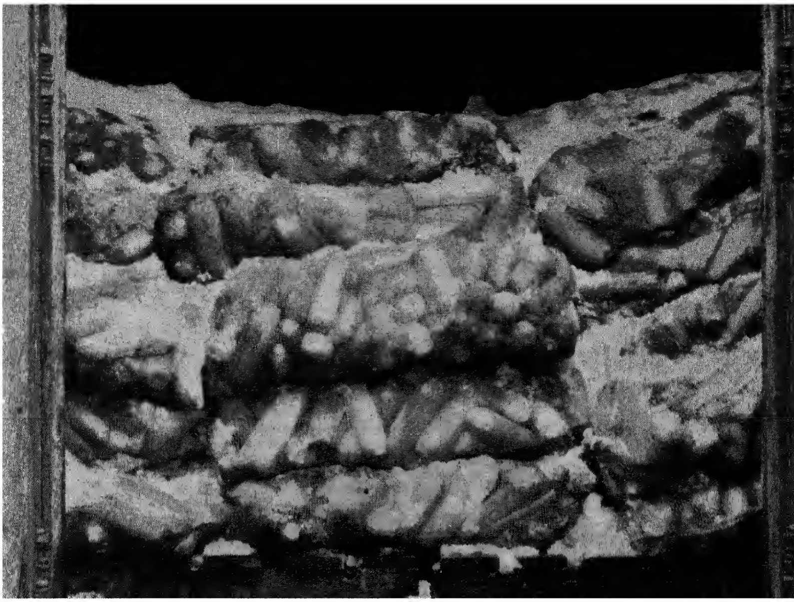

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FIG 81. Arrival of sweet corn in refrigerator car on the market 20 hours after shipping Forty-pound open-mesh bags, containing approximately 60 ears each, are placed 15 layers long, 8 layers wide, and 5 layers deep. Four inches of ice are placed between the layers and 12 inches on top. Bunkers are iced according to standard refrigeration.

After the ears are picked, the sugars decrease and starch increases rapidly, and this change is directly proportional to the temperature. Table 34 presents data showing the effect of temperature on the loss in sugars of the Stowell's Evergreen variety. As shown, the higher the temperature the more rapid was the decrease in sugars and hence the more rapid was the lowering in quality.

Corn should be picked in the early morning, and the ears should be kept in a cool place. Piling the ears or placing them in non-ventilated crates increases the respiration rate and the loss of sugar. Moreover this marked effect of temperature on loss of sugar shows that sweet corn to be canned should be processed immediately after picking.

GRADING. Grading consists in selecting well-filled ears. All poorly filled, worm-eaten, over-ripe ears should be discarded. For long-distance shipment, the ears are packed in ventilated crates or open-mesh bags and shipped in refrigerated cars (Fig. 81).

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CUCUMBERS

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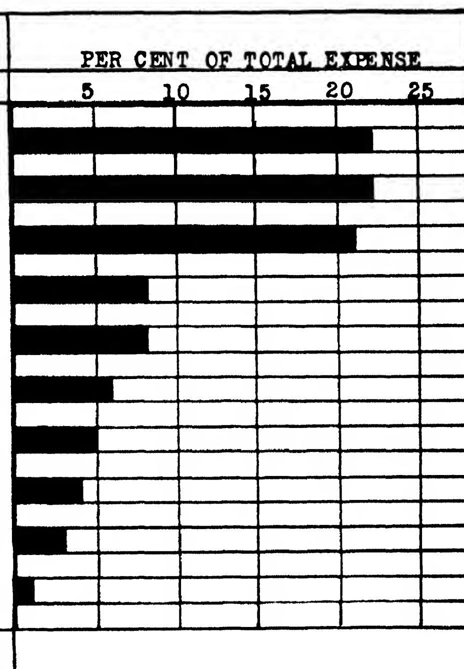
CLASSIFICATION, ORIGIN, AND HISTORY. The cucumber (*Cucumis sativus*) belongs to the same genus as the melon. It is probably a native of Asia and Africa and there is evidence that it has been cultivated in Western Asia for at least 3,000 years. Cucumbers were known to the ancient Greeks and Romans by whom they were introduced into Europe. They have been grown in America since the earliest settlements.

SCOPE AND IMPORTANCE. Cucumbers are included among the 20 important truck crops that are shipped to the markets of the United States in large quantities. The acreage, production, value, and

ITEM	EXPENSE PER ACRE DOLLARS
FERTILIZER	$11.05
CONTAINERS	10.70
MAN LABOR	10.34
RENT	3.75
MULE POWER	3.71
MANURE	2.88
TRUCK EXPENSE	2.73
SEED	1.86
INTEREST	1.46
MACHINERY EXPENSE	0.46
TOTAL	48.95



S. C. Exp Sta. Bull. 301

Fig. 82. Weighted average cost of producing cucumbers, 1929, 1931, and 1932.

carlot shipment of cucumbers grown for market are shown in Tables 35 and 3; while similar information for pickling cucumbers is given in Table 3, page 5.

TABLE 35. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF CUCUMBERS (MARKET) IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [1]	PRICE PER BUSHEL	FARM VALUE	CARLOT SHIPMENTS [2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
Florida	8,013	80	639	2.00	1,275	1,139	Apr.–Nov.
South Carolina	7,871	77	606	.57	302	914	May, June
Texas	6,404	64	412	1.21	413	578	April, May
North Carolina	4,843	89	430	.80	276	454	June
Georgia	2,314	69	160	.89	121	189	May, June
Alabama	1,643	169	278	.64	136	519	May, June
Louisiana	1,281	93	119	.99	118	104	June–Oct.
Arkansas	1,151	76	88	.68	60	91	May–July
Virginia	650	102	66	1.30	86	108	June, July
Other States							
New Jersey	3,043	161	489	.69	335	119	July, Aug.
Maryland	2,383	113	270	.76	204	446	June, July
Total (average) for the 17 leading states	45,644	92	4,187	.99	3,840	5,598	Apr.–Nov.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

AVERAGE PRODUCTION COSTS. Production costs will vary with the locality and year. A 3-year cost study in South Carolina places the average cost of producing cucumbers at approximately $49 per acre (Fig. 82). This figure is probably a fair average cost of production for most of the southern states during recent years.

CLIMATIC REQUIREMENTS. The cucumber is a warm-season crop, and the young plants will be seriously injured by frosts which occur after they come up. Temperatures of 75° to 85° F. are most favorable for growth, but heat is not so essential for cucumbers as it is for melons.

Job 1. Selecting Varieties and Seed

VARIETIES. Varieties should be selected which are vigorous growers, good yielders, resistant to disease, and having desirable market characteristics. The selection of varieties to be grown will also depend upon the use for which the product is intended. There are varieties best suited for slicing purposes and there are others especially desirable for pickling. Table 36 gives a parallel description of the leading varieties grown in the South. A popular variety is shown in Figure 83.

TABLE 36. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF CUCUMBERS

VARIETY	CHIEF USE	SEASON	SIZE IN INCHES, LENGTH, DIAMETER	FRUIT			
				Longitudinal shape	Fruit color	Spine color	Size of seed cavity
A. and C.	shipping	mid-season	10 by 2¼	slightly convex	dark green	white	very small
Chicago Pickling	home, pickling	very early	6½ by 2½	slightly convex	yellowish green	black	large
Clark's Special (Imperator)	general purpose	mid-season	9½ by 2½	very slightly convex	dark green	white	small
Davis Perfect	general purpose	early	9 by 2½	convex	medium dark green	white	medium
Early Fortune	general purpose	early	8½ by 2½	slightly convex	medium dark green	white	medium
Kirby (Stays Green)	home, shipping	very early	7½ by 2½	slightly convex	dark green	white	medium
National Pickling	home, pickling	very early	6 by 2½	very slightly convex	medium green, flecked	black	large
Snow's Perfection Pickling	home, pickling	very early	5½ by 2½	slightly convex	light yellow green	black	very large
Straight-8	shipping, market, home	medium early	8 by 1¾	straight	medium dark green	white	medium

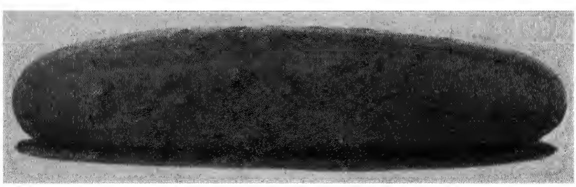
SECURING SEED. It is of the utmost importance to use good seed since the quality of the seed may be the margin of difference between success and failure of the crop. The difference in price between high- and low-quality seed is insignificant as compared with the difference in results. Seed should be purchased from seed-houses which make a point of selling only the best.

Most of the supply of cucumber seed is produced in California, Colorado, and Michigan, although some seed is produced locally in other cucumber-producing areas.

Job 2. Preparing the Seedbed

SOIL PREFERENCES. Cucumbers can be grown on almost any good soil. In the South, however, the commercial crop is produced largely on the light sandy loams of the Coastal Plain regions. A light, loamy, well-drained soil, which contains an abundance of organic matter and is fertile, is very desirable for early cucumbers. Although cucumbers are fairly tolerant to strongly acid soils, best results will be obtained if the soil reaction is kept above a minimum *p*H of 5.5.

PREPARING THE SEEDBED. The sandy soils of the South used for cucumber production are relatively easy to prepare. However, it should be kept in mind that the more thorough the preparation the easier it will be to cultivate and work the crop. Plowing, disking, and



Francis C Stokes and Co , Inc

FIG. 83. The Early Fortune, a general purpose, white-spine variety.

harrowing are all necessary operations. In the South, cucumber land is frequently bedded up in order to facilitate drainage. The height of the beds will depend on the drainage situation. The time of plowing and breaking will vary in the different regions according to the time of planting. For example, in North Carolina, where the planting dates are from March 25 to April 10, the land is broken during February or early March. On the well-drained soils, the land is broken flat and the row-beds made by throwing together two or four furrows with a turn-plow and dragging the ridge down almost level. The rows are bedded up usually when the fertilizer is applied. The final dragging and harrowing is done just ahead of the planter. In more poorly drained soils, high beds are thrown up when the land is first broken and these beds are reworked and dragged down just before planting time.

FERTILIZING. The cucumber is a quick-growing crop, and must be well supplied with nutrients to keep it growing vigorously. Com-

mercial fertilizers containing 4 to 5 per cent nitrogen, 7 to 10 per cent phosphoric acid, and 4 to 5 per cent potash are used by southern cucumber growers. The amounts used will vary from 1,000 to 2,000 pounds per acre according to the fertility of the soil. In North Carolina, the usual recommendation is 1,500 to 1,800 pounds per acre of a 5–7–5 or 4–8–4 mixture for slicing cucumbers, and 1,200 to 1,500 pounds for pickling cucumbers. Fertilizer is applied in a wide band on the beds where the rows are to be located and is thoroughly mixed with the soil. Commercial fertilizers should be applied about a week before planting. Some growers apply half the fertilizer before planting and the rest as a side dressing, but the usual practice is to apply all the mixed fertilizer before planting and to side dress with nitrate of soda or its equivalent in another readily available form at the rate of 100 pounds per acre at the time the vines begin to run. In the Wilmington section of North Carolina, cucumbers are often planted on the lettuce beds before the lettuce is harvested. Since lettuce is heavily fertilized, no additional fertilizer is applied to the cucumbers until the lettuce is harvested, when they are side dressed with nitrate of soda.

MANURING. Animal manures are an excellent source of soil organic matter and fertility. However, in southern field culture, little manure is available and a combination of green-mature crops and commercial fertilizers is employed to meet the requirements of the crop. When a small amount of manure is available, it can be used to advantage by mixing with the soil under the row. Summer soil-improvement crops of soybeans, cowpeas, or velvet beans are recommended. They should be turned under when they have reached full growth but before they mature and become woody. For an early cucumber crop, rye is a practicable winter cover crop, and it should be turned under 3 or 4 weeks before planting time.

Job 3. Planting

Planting dates vary with climatic conditions. Cucumbers are easily injured by frost; consequently, field planting should be delayed until danger of frost is over. Some experienced growers follow a practice of making two or three different plantings, a week apart, the first about 10 days before the average date of the last killing frost. If the first planting is not killed by frost, it will give an extra early crop. If the first planting is killed, the grower still has one of the later plantings on which to fall back. Rows are commonly spaced 4½ to 6 feet apart. On land that has been previously bedded up, the beds are reworked

at planting time and the seed planted in a row down the center of the bed. On well-drained land that is broken flat, the usual practice is to throw up a four-furrow row and drag it flat, drilling the seed down the center of this narrow bed. Seed is sown with a hand drill, a horse drill, or by hand, and should be covered about ½ inch deep. It requires from 2 to 4 pounds of seed to sow an acre, depending on the space between the rows and the method used.

Job 4. Cultivating and Thinning

CULTIVATING. As soon as the plants are up, cultivation should be started and continued frequently enough to keep down weeds and to keep the soil loose. The early cultivations may be reasonably deep, but, since the cucumber is a shallow-rooted plant, all cultivations after the plants begin to run should be shallow and not too close to the plant. Sometimes the vines are turned to permit later cultivation.

THINNING AND WEEDING. After the plants become well established and there is no more danger of loss of plants through insect injury, cucumbers are thinned by hand, one plant being left every 18 inches or two plants to every 3 feet of row.

Hand hoeing is necessary in order to destroy weeds close to the plants, two or three hoeings being generally sufficient to take care of the crop up to the time the plants are too large for further working.

PROTECTION FROM COLD IN THE FIELD. In Florida, cold protection is often provided by making V-shaped troughs of 12-inch boards. The rows are run east and west and the troughs are laid immediately to the north of the plants with one side up. This gives protection from cold during spring, assists in germinating the seed, and prevents the plants from being whipped around by the wind. In case of frost, these troughs can be turned over the plants to protect them.

Job 5. Controlling Diseases and Insects

DISEASES. Cucumbers are subject to a number of diseases which may cause serious losses if not properly controlled. Such losses may be avoided to a large extent by planting on clean land or they may be reduced by seed treatment and spraying. In the South, downy mildew, angular leaf spot, bacterial wilt, anthracnose, mosaic, and root knot are important diseases.

Cucumbers should not be planted in or adjacent to land which grew diseased cucumber, cantaloupe, or watermelon crops during the previous year, because the causal organisms of several of these diseases live over

winter in the soil and on plant refuse. Most cucumber diseases are discussed in Chapter 17.

Downy mildew. (See page 218.)

Angular leaf spot, caused by *Phytomonas lachrymans*, is a bacterial disease carried over winter on the seed and in the soil. It causes small angular water-soaked or tan-colored spots on the leaves. Treat the seed for 5 minutes in a 1 to 1,000 solution of mercuric chloride, wash thoroughly in water, and plant in uninfected soil. Spraying with Bordeaux mixture also will help to control this disease.

Anthracnose. (See page 217.)

Bacterial wilt. (See page 217.)

Mosaic or white pickle is one of the so-called virus diseases which is fast becoming an important cucumber disease in the South. It is characterized by a dwarfing of the plants, mottling, yellowing, and wrinkling of the leaves, and a warting and mottling of the fruits. Mosaic attacks several wild plants, including pokeweed, milkweed, and catnip, overwinters on their roots or seeds, and is carried to cultivated crops in the spring by insects. It is also spread in the cucumber fields by pickers. Thorough eradication of wild host plants near the cucumber fields and strict control of insects are the best methods of mosaic control.

Root knot (Nematodes). (See page 218.)

FIG. 84. Harvesting pickling cucumbers. *N. C. Exp. Sta.*

INSECTS. The principal cucumber insects are discussed in Chapters 11 and 17.

Striped cucumber beetle. (See page 141.)

Twelve-spotted cucumber beetle. (See pages 141 and 142.)

Melon aphid. (See page 135.)

Job 6. Harvesting, Processing, and Marketing

HARVESTING. Slicing or fresh market cucumbers must be fresh and crisp when received by the consumer. The market desires a medium-sized, well-formed, dark-green cucumber. This requires frequent picking and careful and prompt handling. They must be gathered often enough to prevent their becoming too large or overripe. During the height of the season, this may require daily picking, but normally, pickings will be made at 2- to 3-day intervals. Cucumbers usually are picked or cut from the vines, placed in baskets or hampers, and carried to the ends of the rows for packing (Fig. 84). In normal seasons, the first picking can be made in 60 to 65 days after planting.

Pickling cucumbers mature a few days earlier than slicing cucumbers. Frequency of picking will depend on the size desired by the pickling factory. However, the Michigan Experiment Station has published data showing that, at the current prices offered for the different sizes of pickling cucumbers, the growers received the largest net financial returns from picking at 4-day intervals or approximately twice a week, while they suffered a loss from daily picking.

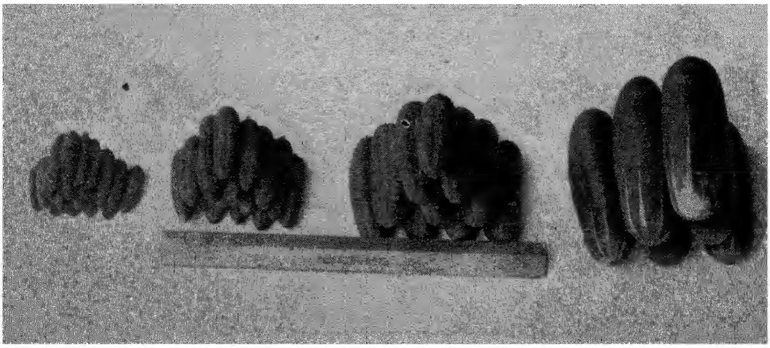


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FIG. 85. Cucumbers graded according to size. The first three lots on the left are pickling sizes. The lot on the extreme right is made up of slicing or fresh market cucumbers.

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FIG. 86. Cucumbers packed in bushel hampers.

GRADING. In the South, grading is usually done by hand in the field or packing shed. Occasionally, U. S. Standard grades are adhered to, with a U. S. Fancy, U. S. No. 1, and U. S. No. 2 classification. However, only two grades are ordinarily made, a No. 1 and a No. 2 grade. Pickling cucumbers are graded into the various sizes on belt grading machines at the pickling factory or brining plant (Fig. 85).

PACKING. Most southern-grown cucumbers are packed in the field, although a few larger growers use packing sheds. A variety of packages is used, most common being the bushel tub basket and the bushel hamper (Fig. 86). The tub basket is becoming very popular in some sections, and boxes are still used to some extent by the extra-early producing areas.

MARKETING. Cucumbers are shipped to distant markets under refrigeration. In recent years, however, a large part of the shipments from the Carolinas has been made by trucks without refrigeration.

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EGGPLANTS

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CLASSIFICATION, ORIGIN, AND HISTORY. The eggplant (*Solanum Melongena* var. *esculentum*), often referred to as the "Guinea squash" in the South, is a native of the tropics. It has been cultivated for many centuries in India, China, and Arabia and was probably introduced into Europe during the Moorish invasion of Spain.

SCOPE AND IMPORTANCE. The eggplant is grown principally in the far South, but is produced on a limited scale as far north as the Great Lakes, and extensive plantings are made as far north as New Jersey. According to reports of the Bureau of Agricultural Economics, United States Department of Agriculture, the average annual shipment from the South, for the five-year period of 1930 to 1934, was 329 cars, of which Florida shipped 259, Virginia 63, Texas 4, Louisiana 2, South Carolina 1, and Georgia 1. The total commercial plantings in the South during this period averaged 2,730 acres annually with a farm value of $422,000. Production in the United States is at low ebb from January to April. Importations from Cuba and Puerto Rico during these months have averaged 212 cars annually for the past 5 years.

AVERAGE PRODUCTION COSTS. It is one of the more expensive vegetable crops to produce because of the high cost of growing plants, high fertilizer requirement, and the need of continuous insect and disease control throughout the growing season. In Virginia, the cost of production to time of harvest varies from $125 to $175 per acre. The cost of producing plants alone may represent an outlay in labor and materials of $50 or more per acre. In the far South where plants are more easily grown the production costs are lower.

CLIMATIC REQUIREMENTS. The eggplant is a warm-season crop and thrives best at relatively high temperatures. Day temperatures of 80° to 90° F. and night temperatures of 70° to 80° F. are considered optimum. It also has a high moisture requirement and responds well to irrigation during periods of drought and high temperature.

Job 1. Selecting Varieties and Seed

VARIETIES. The principal varieties grown in the South are Black Beauty, New York Improved Purple, Florida High Bush, and New Orleans Market.

Black Beauty. Fruits are purplish black, weighing 2 to 3 pounds when mature. Plant growth is spreading. This variety is preferable from the standpoint of earliness, appearance, and quality.

Florida High Bush. Fruits are smaller, more elongated, lighter in color, and slightly inferior in quality to the Black Beauty. Plants make an upright type of growth. In spite of the poorer quality, the variety is very popular in the far South because of its resistance to disease and to excessive heat.

New Orleans Market. Fruits are larger than Florida High Bush, but growth is similar. This is a new variety.

New York Improved Purple. Fruits resemble Black Beauty, but are slightly larger, lighter purple in color, and later in maturity. Type of growth is similar to Black Beauty, but is spineless.

SECURING SEED. Seed should be secured only from disease-free plants, since fruit rot, the most serious of eggplant diseases, is carried inside the seed. The fruits are allowed to mature on the plant, then harvested and crushed with special machinery for macerating the pulp. The seed is separated from the pulp by washing without fermentation and quickly dried on cloth-covered frames to prevent discoloration.

Job 2. Preparing the Soil

SOIL PREFERENCES. For best development, the eggplant requires a well-drained, exceptionally fertile sandy-loam soil with a high organic content. In Florida, well-drained hammock lands are preferable because of the fertility and moisture-holding capacity of this type of soil. In Virginia, protection on the north and west by woods or windbreaks is desirable because the young plants are susceptible to wind injury soon after being set in the field.

BREAKING AND CONDITIONING. The soil should be in excellent physical condition, free from undecomposed plant residues. For the fall crop in the far South, soil should be plowed several months in advance of planting to permit thorough decomposition of organic matter, and be harrowed at regular intervals to conserve soil moisture, which is so necessary for the newly set plants. Areas for spring planting, if in

cover crops the previous year, should be plowed early in the fall and again in the spring.

FERTILIZING AND MANURING. Soils low in humus should be planted to a green-manure crop the previous year, or well-rotted stable manure should be used in the furrow at time of setting. One to 2 tons of commercial fertilizer analyzing 5–7–6 are used per acre in Florida, while one to 1½ tons of 6–6–5 are used in Virginia. Part is applied at time of planting and the remainder as a side dressing. In Virginia, a 9–5–4 fertilizer is frequently used as a side dressing. Applications of nitrate of soda during the period of fruit production are sometimes necessary to keep the plants in a growing condition and provide an abundance of foliage to protect the fruit from sun scald.

Job 3. Growing Plants, Planting, and Cultivating

GROWING PLANTS. This is probably the most important and most difficult job in the whole procedure of eggplant culture. Eggplants are very exacting as to temperature, moisture, and insect and disease control in the plant bed. Eggplants are not readily transplanted to the field, particularly in periods of dry weather, unless the plants are stocky and a fair-sized clump of soil is attached to the roots when the plant is

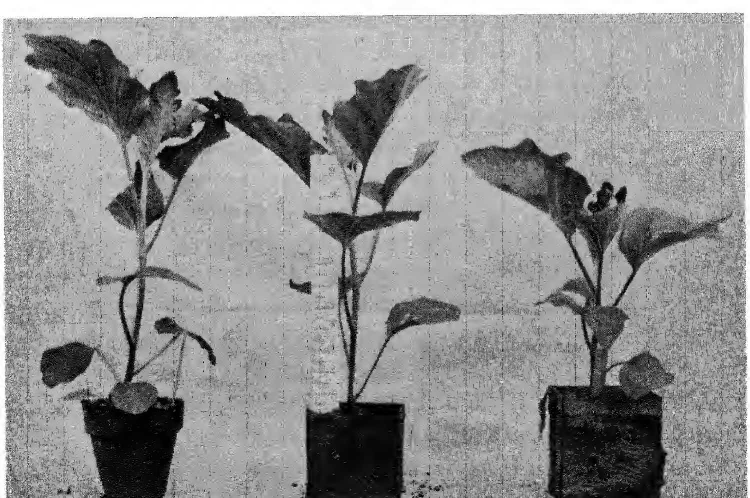

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FIG. 87. The stocky plant on right, grown in a 4½ by 4½ by 5 inch veneer band, is a desirable size for planting in the field. The two taller plants, grown in smaller containers, are too spindling.

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FIG 88. Yield of eggplants at third harvest from alternate rows of paper-mulched and unmulched plants

removed from the bed (Fig. 87). It is usually desirable to transplant the seedlings, when about 4 to 5 inches high, into veneer bands or pots, or space them at least 4 inches apart in the plant bed, so that the soil can be cut out in squares with a knife and a block of soil be lifted with the plant when transferring to the field. In Virginia, veneer bands $4\frac{1}{2}$ by 5 inches are commonly used. Studies at the Virginia Truck Experiment Station have shown them to be more satisfactory in every respect than clay or paper pots or cutting the soil in squares.

In the far South, seeds are planted from June to August for the fall and early winter crop and in February and March for the spring crop. In Virginia, seed is planted about February 1 in the greenhouse, or in manure- or electrically-heated hotbeds. Plants 4 to 5 inches tall are transplanted to veneer bands in hotbeds where night temperature is maintained between 70° and 80° F., and day temperature between 80° and 90° F. When the plants start to crowd, the lower leaves are removed and one-half of each remaining leaf is clipped off with shears. The plants should be gradually hardened by proper ventilation and by withholding water before being set to the field.

PLANTING AND SETTING. Plants are usually set 3 to 4 feet apart in 4- to 5-foot rows. The method in most sections is to plow out furrows, set the plants slightly deeper than in the seedbed, and firm the soil by hand around each plant. As soon as the row is planted, furrows

should be thrown to it with a small plow so the trench between the plants is filled with soil.

CULTIVATING. Frequent shallow cultivation should be given to eradicate weeds, and some hand hoeing may be necessary in weedy soil. Since the eggplant is a long-season crop, careful weed control before the plants become large is important.

MULCHING. Experiments by Parker at the Virginia Truck Experiment Station over a period of 6 years showed that the use of mulch paper greatly accelerated the growth rate and production of fruits each year (Fig. 88). The increases resulting from mulching as compared to shallow cultivation to remove weed growth for an average of the 6 years was as follows: First harvest 24.2 crates; second 27.4 crates; third 28.4 crates; fourth 21.3 crates; last harvest only 3.3 crates. The average increase in number of marketable fruits was 53.8 per cent during seasons of relatively light rainfall and only 9.3 per cent for seasons of heavy rainfall. The cost of lightweight paper, 3 feet wide, was about $43 an acre.

Job 4. Controlling Diseases and Insects

DISEASES. The eggplant is very susceptible to serious injury in all stages of growth by a number of diseases which are widely distributed in the South.

Fruit rot, caused by the fungus *Phomopsis vexans,* is probably the most serious and widespread disease of eggplants. It occurs in the stems, leaves, and fruit. The fungus attacks the stems of the young plants at the soil line, often girdling the stem and causing the plant to break off or at least to wilt and die. The fungus may attack the stem of the older plant at any point, causing sunken, oval, dark-brown cankers. Leaf injury first appears as brown, round spots, the centers of which later turn gray. The fungus produces round or oval, tan-colored areas on

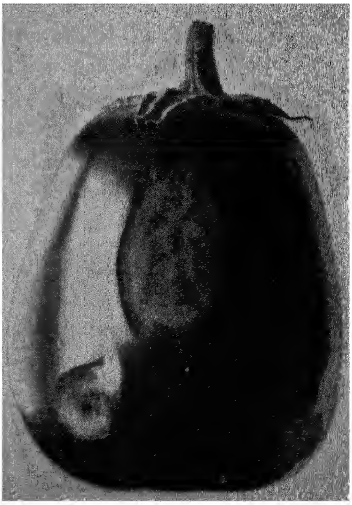

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FIG. 89. Eggplant fruit showing both round and oval fruit-rot lesions caused by *Phomopsis.*

the fruit (Fig. 89). Frequently, these start near the calyx cap, causing the fruit to drop prematurely. The variety Florida High Bush shows considerable resistance to this disease. According to Edgerton and Moreland, the fungus may be carried over in the seed. The use of disease-free seed and planting in uninfested soil is the best preventive. Since it is seldom possible to meet these requirements, a regular program of spraying or dusting should be followed. Edgerton and Moreland in Louisiana recommend the use of Bordeaux spray with a sticker at regular intervals during the growing season. Nine to 13 applications were needed to give good protection. In Virginia, Spencer and his co-workers obtained a 200 per cent increase in yield by 12 applications of Bordeaux dust with an arsenical. Much of this increase was attributable to control of *Phomopsis* which was very severe that year. Arsenicals alone gave as great increase as Bordeaux with arsenicals in 1923, when flea beetles were very numerous and *Phomopsis* was not abundant.

Wilts, including *Verticillium*, *Fusarium*, and bacterial, are prevalent in the more important eggplant-producing areas. They cause wilting and yellowing of the foliage and finally kill a part or the whole of the plant. They are especially insidious because the organism causing the disease may live for several years in the soil. Seedbed and field sanitation and crop rotation are necessary if any of these diseases become established. Wilts cannot be controlled by spraying with fungicides because the disease-producing organism is inside the conductive tissues of the plant.

INSECTS. Important insects attacking eggplant in the different stages will be discussed briefly.

Flea beetles (*Epitrix* spp.) cause considerable damage in plant beds and fields if not controlled. Frequent spraying or dusting with Bordeaux serves as a repellent, but is more effective if an arsenical is added.

Colorado potato beetles (*Leptinotarsa 10-lineata*) are often prevalent in areas where potatoes are grown. They can be controlled easily by arsenical dusts or sprays, as described on pages 275 and 276.

Aphids (*Aphis* spp.) and the *Lace Wing* can readily be controlled by nicotine sprays or dusts, as explained on page 135.

Red spider (*Tetranycleus* spp.) is a small reddish mite, which may become numerous on the under sides of the leaves and destructive in dry weather. It can be controlled by dusting with a mixture of equal parts of lime and finely ground sulfur.

Eggplant tortoise beetle (*Cassida pallidula*) is a leaf-eating insect of minor importance, which can be controlled by arsenical sprays or dusts.

Job 5. Harvesting, Processing, and Marketing

HARVESTING. The fruits when of marketable size are clipped from the plant leaving the calyx or cap attached to the fruit. Very careful handling is essential to prevent even slight bruising which will disfigure the fruit.

GRADING AND PACKING. If the fruits are harvested regularly at a definite size, there will be no need for grading with the exception of discarding all diseased, misshapen, or bruised fruit. The individual fruits are wrapped in paper or placed in small paper sacks and packed in crates, bags, or baskets, for shipment. The 18- by $15\frac{5}{8}$- by 12-inch crate is the standard package for Virginia, an 11- by 14- by 22-inch crate is used in Florida, and the bushel basket is commonly used in Louisiana and Texas.

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22

IRISH POTATOES

H. P. Stuckey, Georgia Experiment Station, Contributor

CLASSIFICATION, ORIGIN, AND HISTORY. The Irish potato (*Solanum tuberosum*) belongs to the family *Solanaceae* and is a close relative of the tomato, eggplant, pepper, tobacco, and the wild nightshade. The Irish potato and Indian corn are the New World's greatest contributions to the food supply of mankind.

Peru in South America is thought to be the place of origin of the Irish potato; some authorities, however, believe that it was native also to parts of Mexico. When and how the Irish potato reached the southern part of the United States is not known.

The growing of Irish potatoes as a worthwhile food crop in this country was of little significance prior to the influx of Presbyterian immigrants from Ireland in 1718. The crop gained its greatest impetus in America, however, immediately after 1846, the year that blight destroyed the potato crop in Ireland and caused a famine.

Furthermore, the reliance of the Irish people on the potato as a food crop and their influence on its extended culture and use in this country were no doubt responsible for this product being called the Irish potato rather than the Peru or South American potato. The word Irish as a prefix to the word potato has a very definite meaning in the rural South, where the single word potato is often understood to mean sweet potato. In the North, the reverse is true.

SCOPE AND IMPORTANCE. Three centuries ago the Irish potato was scarcely known as a food crop in either Europe or America. Today, however, its culture encircles the globe in both temperate zones and stands out as the most important food crop of the world.

The world yield of Irish potatoes, exclusive of Russia and China, for the year 1933–1934 is estimated as 5,612,000,000 bushels.[1] Other food crops of the world in order of rank are wheat, corn, rice, and oats.

The acreage and production of Irish potatoes in the southern states do not measure up to those in some of the northern states and European countries, because of less favorable climatic conditions; yet the increase

[1] U. S. Dept. Agr., Yearbook of Agriculture, 1935.

in price due to selling the crop as new potatoes partially offsets the handicap of low yields.

Distribution and acreages of all potatoes by states are shown in Figure 90, and the acreage, value, carlot shipment, and shipping season of early Irish potatoes are shown in Table 37.

TABLE 37. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF EARLY IRISH POTATOES IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE [1]

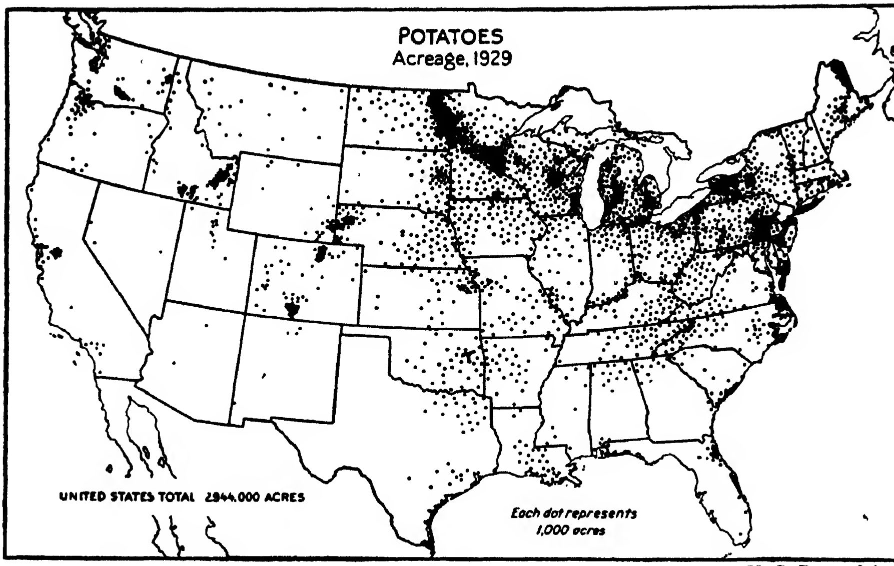
STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [2]	PRICE PER BUSHEL	FARM VALUE	CARLOT SHIPMENTS [3]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
Virginia	64,457	145	9,377	.77	7,203	16,267	June–Sept.
North Carolina	30,643	150	4,589	.73	3,338	7,700	July–Sept.
Texas	26,929	78	2,099	1.07	2,245	3,215	Mar.–June
Florida	23,829	105	2,508	1.29	3,227	4,720	Feb.–May
Louisiana	21,429	74	1,580	.78	1,236	2,448	May, June
South Carolina	12,257	151	1,850	.88	1,636	3,200	May, June
Alabama	10,800	119	1,282	.75	958	2,954	May
Oklahoma	9,871	100	990	.72	699	1,879	June
Other States							
New Jersey	34,114	182	6,206	.74	4,621	4,755	July–Sept.
Kansas	14,257	124	1,762	.66	1,166	2,110	June–Aug.
California	13,786	198	2,725	.75	2,048	8,674	Jan.–Dec.
Maryland	7,829	136	1,065	.73	781	1,702	June-Aug.
Total (average) for the 19 leading states	293,000	132	38,622	.81	31,114	70,268	Jan.–Dec.

[1] Does not include main crop of Irish potatoes.

[2] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[3] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments. Includes all potatoes, both early and late crop.

While prices and yields of potatoes vary greatly between the southern and northern states as is shown in the foregoing table, yields and prices also vary within the southern area. For example, in southern Florida where high fertilization and intensive culture are given, both yields and prices usually surpass those in the main body of the South. The advance in price is especially emphasized for the reason that the crop can be harvested and placed on the market in late winter when there is little competition from other regions. Since the Irish potato is not a major crop in most of the southern states, its culture on a commercial scale



U. S. Dept. of Agr.

FIG. 90. Distribution and acreage of Irish potatoes.

is usually confined to special truck-growing districts which attract potato buyers, develop skilled labor for growing the crop, and allow the purchase of seed stock and other supplies co-operatively. This is especially true of those districts which emphasize the production of early potatoes, such as the Hastings district, in Florida; Savannah district, in Georgia; the Beaufort and Charleston districts, of South Carolina; Beaufort County, North Carolina; Norfolk and the eastern shore of Virginia; Columbia, Tennessee; Fort Gibson, Oklahoma; Fort Smith, Arkansas; Eagle Lake, Wharton, and Brownsville, Texas; Alexandria and Bayou Lafourche, Louisiana; and Mobile, Alabama.

AVERAGE PRODUCTION COSTS. The costs of growing an acre of Irish potatoes vary considerably, ranging from $40 in some areas to more than $100 in some of the intensive sections. The items of expense include labor, fertilizer, seed, spray materials, and packages for shipping. It requires from 100 to 125 man hours to grow, harvest, and market an acre of potatoes. The greatest cash outlay for materials is for seed, fertilizer, and packages if the crop is marketed in barrels or hampers, as is the usual practice with new potatoes.

CLIMATIC REQUIREMENTS. The Irish potato requires a cool growing season with an abundant and well-distributed rainfall. Since the seed pieces will usually sprout at temperatures ranging from 40° to

50° F., it is the common practice in most southern sections to plant Irish potatoes 5 or 6 weeks before the last spring frost is expected. It requires about this length of time for the eyes to sprout and the young plants to push through about 3 inches of soil, the usual depth of planting. There is, of course, some risk of the young plants being injured by frost, although the increased yields and prices obtained from early planting warrant the grower taking this risk. Late plantings in the South have to mature during very hot and often dry weather, and seldom produce satisfactory crops. Atmospheric temperatures ranging from 65° to 75° F. which occur in the early spring and in the fall in the South are most favorable.

Those districts prepared to irrigate are more certain of success. Irrigation is decidedly important for growing a fall crop of Irish potatoes, since rainfall is usually not so well distributed at that season. On the average, a fall crop of Irish potatoes is much more difficult to grow and much less certain than the spring crop.

Job 1. Selecting Varieties and Seed

VARIETIES. The Cobbler, Triumph, and Spaulding No. 4 are the varieties most generally grown in the South for the early market. The White Star is grown to some extent as an early market variety in Louisiana.

The Jersey Red, Lookout Mountain (McCormick), and Green Mountain are used for the fall crop in parts of Virginia, western North Carolina, northern Georgia, and eastern Tennessee. A variety not well known in commerce, called Snowflake, is quite popular for home use and local markets in the mountainous sections of the upper South. This variety is also known in some localities as the White Star or White Elephant. It is doubtful, however, if it is the same as the White Star variety grown in Louisiana. Several varieties are described in Table 38, and shown in Figure 91.

SECURING SEED. It is desirable to purchase certified seed when possible. Most states growing seed potatoes commercially have associations which send out inspectors to inspect both fields and storage bins of potatoes before giving a certificate of inspection to show that the seed stock is standard in type and free of serious diseases. Field inspection of the plants is the only way known to identify some of the virus diseases, such as mosaic, which are carried in the tubers. This is discussed under the disease section (Job 6) of this chapter.

The second or fall crop of Irish potatoes grown in the mountainous sections of North Carolina, Georgia, and Tennessee, on the eastern shores of Virginia and Maryland, and in sections of Oklahoma and Arkansas are held over winter and used for seed purposes in the following spring. This seed stock does not mature a crop quite so early as seed from the North, but the yields are generally satisfactory.

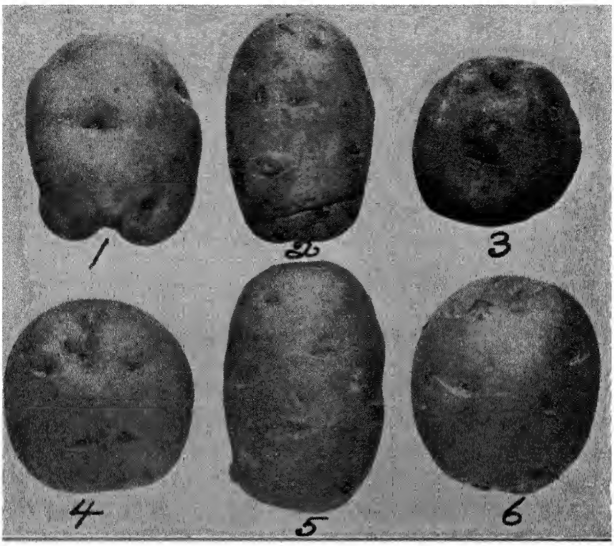


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FIG. 91. Early varieties of Irish potatoes: 1. Irish Cobbler; 2. Early Ohio; 3. Bliss Triumph. Late varieties: 4. Russet Rural; 5. Green Mountain; 6. Rural New Yorker

More recently, seed potatoes have been saved from the early or main crop of the mountainous sections of Georgia, North Carolina, and Tennessee to be shipped to south Florida for the production of winter crops. The crop matures early enough to provide the necessary rest period of the seed prior to planting.

Job 2. Preparing the Soil

SOIL PREFERENCES. The Irish potato must have a fertile soil for even moderate yields. If drainage is good, heavy clay soils can be made to produce potatoes by adding large quantities of organic matter, or very porous sandy soils can be used by adding heavy applications of commercial fertilizers.

Table 38. Outstanding Characteristics of the Principal Varieties of (Irish) Potatoes

Variety	Season	Size and Habit of Plant	Size of Leaf	Flower Color	Tuber		Number and Depth of Eyes
					Shape	Color	
Bliss Triumph	very early	dwarfed, compact	medium	purple	round with blunt ends	red	medium, medium
Burbank	medium late	medium large, bushy	medium	white	long, cylindrical	dull white	medium, shallow
Early Rose	early	stout, erect	large	white	flattish, oblong	flesh	numerous, shallow
Green Mountain	medium late	very large, semi-spreading	medium large	white	flattened, oblong	creamy white	medium, variable
Irish Cobbler	early	medium, spreading	large	lilac	roundish	creamy	medium, medium
Jersey Red	fall crop	large, stocky, vigorous	large	lilac	rough, flattened, oblong	red	medium, shallow
Lookout Mountain (McCormick)	late	large, upright	medium	lilac	round, oblong	flesh	numerous, deep
Snowflake	second early	medium	medium	white	elongated, oval	white	few, shallow
Spaulding No. 4	medium early	medium, erect	medium large	white	elongated	flesh	medium, shallow
White Elephant	medium	stout, vigorous	medium	white	long	white, pink tint	numerous, medium
White Star	medium early	stocky, vigorous	medium	white	oblong	white	medium, medium

PREPARING THE SOIL. The land should be broken deeply during the winter and harrowed just before planting in the early spring. Where the land is very flat, it should be thrown up into high beds and a ditch provided along the ends of the rows for taking off the drainage water.

Job 3. Fertilizing and Manuring

FERTILIZING. Nitrogen, phosphorus, and potash are required in a fertilizer mixture for practically all the soil types used for growing Irish potatoes in the South. There may be some exceptions in the

case of some of the muck soils containing a high percentage of nitrogen. The valley lands of northern Georgia, western North Carolina, and eastern Tennessee, and possibly others of similar types, respond more to phosphoric acid than to either nitrogen or potash. A 6–10–6 fertilizer seems well suited for general use for Irish potatoes. The rate of application varies from 600 to 1,200 pounds per acre; however, heavier applications have given a profit under some conditions. At the Georgia Mountain Experiment Station 600 pounds of this fertilizer mixture per acre produced 205 bushels of Triumph potatoes. The same fertilizer applied at the rate of 1,800 pounds per acre (1,200 pounds applied broadcast and 600 drilled in the row before planting) produced 319 bushels.

The sandy loam soils of the coastal plains from Virginia southward respond well to a 5–7–5 or 5–8–5 fertilizer. The rate of application ranges from 800 pounds to a ton per acre. The previous treatment of the soil and its texture will of course necessitate variations in practices to fit local conditions. The heavier types of soils of the Piedmont section of the southeastern states and those of the southern states to the west require somewhat smaller applications of fertilizer, averaging 4–8–4.

A 4-year experiment conducted by the Arkansas Experiment Station in south Arkansas showed that 1,000 pounds of 5–10–5 fertilizer increased the yield of marketable potatoes from 27 to 165 bushels per acre (Table 39).

Table 39. The Effects of Different Fertilizers on the Yield of Irish Potatoes. University of Arkansas Fruit and Truck Branch Experiment Station

Amount and Treatment	Grades	4-Year Average Acre Yield in Bushels	Gain over Check	Percentage of Check
No fertilizer — check	marketable	27.10	00.00	100
	culls	6.40	00.00	100
1,000 pounds 5–10–5 plus 10 tons manure	marketable	216.22	189.12	798
	culls	17.21	10.81	269
1,000 pounds 5–10–5	marketable	165.39	138.29	610
	culls	14.16	7.76	221
1,000 pounds 5–0–5	marketable	47.70	20.60	176
	culls	6.59	.19	103
1,000 pounds 0–10–5	marketable	40.18	13.08	148
	culls	8.89	2.49	139
1,000 pounds 5–10–0	marketable	97.58	70.48	360
	culls	14.14	7.74	221

Ark. Agr. Exp. Sta. Bull. 333.

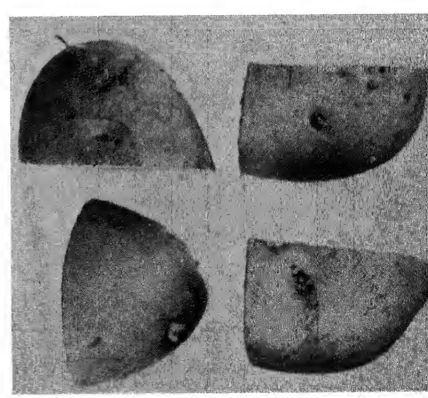
There is some preference for sulfate of potash as a source of potash, and for a part of the nitrogen to come from an organic source, such as cottonseed meal and fish meal, but where there is a considerable difference in price, it is possibly to the advantage of the grower to use the muriate or chloride form of potash and mineral nitrogen.

MANURING. Animal manures should be used where available. Summer cover crops turned under in the fall are good soil improvement crops for Irish potatoes to follow in the spring. Winter cover crops are not well suited for the reason that the potatoes are planted before the crop has time to make any appreciable amount of spring growth.

Job 4. Planting

TREATING SEED. Whether certified or common seed stock is used, the potatoes should be treated with a disinfectant before planting. They should be disinfected before they are cut for planting with either (1) one pint of commercial formaldehyde solution mixed with 30 gallons of water, or (2) four ounces of corrosive sublimate dissolved in 30 gallons of water.

The solutions should be handled in wooden vessels, and the potatoes should be soaked in either solution from 45 minutes to 1½ hours and spread immediately after being removed in order for the surfaces to dry. They are then ready to be cut and planted.



Progressive Farmer and Southern Ruralist

FIG. 92. One to 1½-ounce, blocky seed pieces with one or more well-placed eyes are desirable.

PLANTING RATE. From 9 to 15 bushels of seed potatoes are required to plant an acre. The heavier rate of seeding should be employed on the most fertile soils.

A medium-sized tuber is cut into 4 to 6 pieces, each piece containing one or more eyes (Fig. 92). Very small pieces containing only one eye frequently produce weak plants. If the pieces are cut too large, it will require a large amount to plant a given area, thus increasing the cost of seed.

There are mechanical devices for cutting potatoes for planting, but if the work can be done by hand, there will be a greater certainty of each piece containing one or more eyes. Potatoes should be planted soon after cutting, or the cut pieces should be cured by keeping them in an atmosphere of high humidity (90 per cent or higher) and at a temperature of 60° to 65° F. If the cut seed is to be kept more than a week, curing is desirable.

PLANTING TIME. In most sections of the South, Irish potatoes should be planted about 5 or 6 weeks before the last spring frost is expected. In the milder sections of the South, as in Florida and in the Gulf Coast sections of Texas, the main planting is done in late fall or early winter. In the middle and upper portions of the South, plantings are usually made in February and March respectively.

PLANTING METHODS. The grower has a choice of one- or two-row planters, which will enable him to plant rather large areas in a comparatively short time, or he may drop the seed pieces by hand. The usual custom is to space the rows from 32 to 36 inches apart and drop the seed pieces from 12 to 15 inches apart in the row. Growers in some sections space their rows 5 to 6 feet apart and interplant with some later crop. They claim that a larger return will result from limited quantities of seed and fertilizers. Close spacing on good land well supplied with moisture tends to increase yields. The seed pieces should be covered from 3 to 4 inches deep. On flat lands where drainage is difficult, the potatoes are planted only about 2 inches below the general level of the land and ridges are thrown up over the rows, covering the seed pieces about 2 inches more. Since the tubers are formed on the plant above the planted seed piece, it is well to plant deeply on lands where the crop is subject to dry weather. Some growers follow the plan of throwing up high ridges over the rows after planting, covering the seed pieces 5 to 6 inches deep. Then just before the young plants emerge a spike-tooth harrow is run over the land, killing the first crop of small weeds and breaking the crust of the soil to assist the plants in coming through.

Job 5. Cultivating and Spraying

CULTIVATING. If the land has been deeply broken and well harrowed before the potatoes are planted, the cultivation of the crop is a rather simple task. Sufficient shallow cultivations should be given to keep down weeds. At the same time, the soil should be gradually

worked to the plants as they increase in height. If the soil becomes compact after planting, it may be necessary to give one deep cultivation soon after the plants come up. Following this, however, deep cultivation should be avoided to prevent serious injury to the roots.

By the time the plants bloom freely and begin to form tubers, beds or ridges in which the potatoes form should be completed and the crop laid by.

SPRAYING. Contrasted with northern potato-growing regions, where spraying with Bordeaux mixture has usually resulted in profitable returns, there is much less evidence for such returns in the South as a whole. It is only in certain more or less localized regions, as in parts of Florida, that such spraying has resulted in sufficient increase in yield, without otherwise lowering the value of the crop, to warrant its use. Since a considerable part of the southern crop is grown to supply a demand for early spring potatoes, and since earliness is an important factor in the price received for such potatoes, any practice which tends to prolong the life of the plants beyond the dates of consumer demand tends to lower the selling price.

Where late blight is common in the South, as in parts of Florida, spraying with Bordeaux mixture 4–6–50 (in terms of hydrated lime), to which may be added 1½ pounds of lead arsenate or calcium arsenate, if Colorado potato beetle is prevalent, has been found to be profitable.[1] Likewise, where tip and margin burning of leaves, induced by leafhoppers, can be controlled without seriously injuring the foliage with Bordeaux sprays, and where earliness of harvesting is not important economically, such sprays may at times be profitable. However, during very warm weather, Bordeaux sprays have been reported to cause as much damage to the foliage in the South as the leafhoppers.[2] The first spray should be applied when the plants are 6 to 8 inches high, and the others at 10- to 14-day intervals.

Job 6. Controlling Diseases and Insects[3]

DISEASES. The Irish potato is subject to a great variety of fungus, bacterial, and virus diseases, requiring a variety of control methods.

[1] Gratz, L. O.: *Potato Spraying and Dusting Experiments in Florida*, Fla. Agr. Exp. Sta. Bull. 222, 1930.

[2] Rosen, H. R.: *Etiology of Tip and Margin Burning of Irish Potato Leaves*, Forty-sixth Ann. Rept. Ark. Agr. Exp. Sta. Bull. 312, 1934.

[3] Potato Diseases, prepared by B. B. Higgins, Botanist, Ga. Exp. Sta. Potato Insects, prepared by T. L. Bissell, Entomologist, Ga. Exp. Sta.

Some of these diseases cause serious losses wherever the potato is grown, while others are more localized. Many of the most important diseases are seed-borne. Therefore, the importance of disease-free seed and seed treatment is being recognized by growers everywhere. Crop rotation is necessary to prevent increasing destructiveness of organisms that live over in soil and on old decaying vines and tubers, and spraying or dusting is necessary for control of insects and leaf diseases.

Early blight, caused by *Alternaria solani*, appears as large grayish-brown spots, usually showing concentric light and darker markings on the leaves. As the spots enlarge, they coalesce and finally involve the entire leaf.

This disease is very common in the South when a rainy period occurs during May or June. It is often confused with tip-burn, which becomes serious during dry, hot weather immediately following a period of excessive moisture. Together they cause heavy reduction of the crop nearly every year, sometimes as much as 50 per cent.

Spraying with Bordeaux mixture will control early blight and will retard development of tip-burn.

Late blight, associated with *Phytophthora infestans*, is usually considered the most serious leaf disease of the potato. Ordinarily it is not important in the South.

Mosaic is a virus disease, appearing as a mottling of the leaves with paler areas interspersed between darker ones, and accompanied by more or less crinkling. The loss of chlorophyll causes reduced elaboration of starch and consequent reduction of the tuber yield. The disease is carried from year to year in seed tubers. In the field, it is spread by insects, principally the potato aphid, which carries the juice from infected to healthy plants. Control consists in the use of properly certified seed.

Leaf roll is a virus disease in which the affected plants are of a paler green color, more upright in habit, with the lower leaflets rolled upward. The yield is more seriously reduced than by mosaic. The means of transmission and methods of control are the same as for mosaic.

Spindle tuber is also a virus disease which was recently introduced from Europe, and has already become widely distributed in this country. The leaves are smaller and of a darker green color than normal, and the margins are usually inrolled. The tubers are elongated and have more prominent eyes. Transmission of the disease and methods of control are the same as for mosaic.

Scab, resulting from attacks of *Actinomyces scabies*, is recognized by most potato growers by the characteristic pitting of the tubers. Badly

pitted tubers are unsalable. The fungus lives over in the diseased spots on the surface of healthy tubers, and in the soil. It grows best in slightly alkaline, neutral, and slightly acid soil, and apparently does not live more than one season in southern soils, probably because of the high degree of acidity and hot, dry condition of the soil during the summer months. Yet in the South, seed selection and seed treatment must be practiced in order to produce clean, salable stock.

Black leg is a bacterial disease caused by *Erwinia carotovora.* Diseased plants assume a yellowish-green color, the stem is blackened below the soil line, the soft parts and the old seed piece decay, and with continued moist conditions the new tubers may decay in place. They become infected and may rot in storage or in transit to market. The bacteria may be carried either within or on the surface of the potato. When such infected tubers are planted, the bacteria may enter the sprouts. The bacteria also live over in the soil. Control methods include the use of disease-free seed stock, seed treatment, and crop rotation.

Black scurf, caused by *Corticium vagum*, consists of irregular, scurfy, blackish patches (sclerotia) on the surface of the potato. When such infected tubers are planted, the fungus often attacks the sprouts, killing them before they emerge from the soil or causing wilting and death at a later date. Badly infected tubers should not be used for seed. Large sclerotia are difficult to kill by the most thorough seed treatment. Tubers showing slight infection may be used when clean seed cannot be obtained, but they should be treated before planting. Ordinarily this disease is unimportant in the South.

INSECTS. More than 25 species of insects have been found injurious to the Irish potato in the southern states, but most of these are seldom seriously destructive over any great area (Fig. 93).

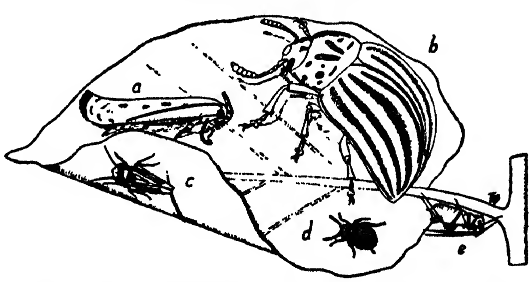


FIG. 93. Important Irish potato insects: *a*, tuber moth; *b*, Colorado potato beetle; *c*, potato leafhopper; *d*, potato flea beetle; *e*, potato aphid.

Colorado potato beetles (*Leptinotarsa 10-lineata*) are thick-bodied, yellow beetles about $\frac{3}{8}$ inch long, with dark-brown stripes on the wing covers. The young are red and soft-bodied, and cling to the edges of the leaves. Yellow eggs stand in close groups on the under sides of leaves.

Adults and young eat irregular holes in the leaves and branches, beginning to feed as soon as plants are up.

This beetle is the best-known and most destructive enemy of potatoes in the United States. Since its spread eastward from its native home in the Rocky Mountains, it has now occupied all the South except the lower part of Florida. The potato is its favorite food plant; it also feeds freely on tomato, eggplant, and horse nettle. Regular applications of an arsenical either in spray or dust form are necessary to control this insect. Calcium arsenate is the best material as regards effectiveness and cost. If used in a spray, it should be applied at the rate of 1½ pounds to 50 gallons of spray mixture.

Potato flea beetles. (See page 140.)

Potato leafhoppers (*Empoasca fabae*) are small, green, active-jumping, streamlined insects which suck juice from the under side of the leaves, causing the tips to turn brown and the edges to curl upward.

The leafhopper is the worst pest of potatoes in the north central states and it occurs over the East and South, except in the southern parts of Florida and Texas. Its feeding brings about the condition called hopperburn. Beans, alfalfa, and apple trees also suffer from this insect and many other herbaceous and woody plants serve as hosts. Bordeaux mixture is toxic to young hoppers and repels the mature insect.

Potato aphids. (See page 135.)

Potato tuber worms (*Gnorimoschema operculella*) are pinkish-white caterpillars, approximately ¼ inch long. They mine the leaves and stems and burrow into the tubers. Late potatoes and those in storage are more frequently attacked than is the early crop. The tuber worm has been of importance in California, Virginia, and Maryland. Hot, dry weather in the field and the accumulation of potatoes in storage encourage this pest. • Eggs are laid by moths on exposed tubers, during the late afternoon and night. In Maryland, infestation of potatoes by the tuber worm is prevented by hilling the tubers 6 to 8 inches deep about 40 days after planting. Tubers, after being dug, should not be left on the ground overnight, and should not be covered with potato vines.

Nematodes (Root knot). (See page 218.)

Other insect pests. In addition to these more specific pests, there are several general feeders which sometimes become destructive to potatoes. They include blister beetles, white grubs, wireworms, plant bugs, and the vegetable weevil. The general treatment of these is discussed in Chapter 11.

Job 7. Harvesting, Processing, and Marketing

Irish potatoes of the early crop in the South seldom reach full maturity on account of dry weather, early blight, tip-burn, and other conditions which interfere with normal growth. Consequently, the plants usually begin to die down before the crop is mature even though good culture has been given and a spray schedule followed. As this stage approaches, harvesting is in order. Some growers harvest even earlier if the price for early or new potatoes is high. On the other hand, harvesting is delayed when prices are low.

HARVESTING AND GRADING. Harvesting machinery ranges from the one-horse plow to the elevator digger, depending on the acreage to be harvested. The object in every case, however, is to get the potatoes out of the soil with the least possible injury and at a cost the grower can afford. One common method is to plow the potatoes out with a two-horse turning plow or a No. 10 potato shaker and have them picked up by inexpensive labor, often women and children.

In some districts, the potatoes are sorted or graded as picked up. In others, they are hauled in crates or baskets to a grading machine, where they are graded by sizes and packed in stave barrels holding 9 pecks each. After the barrels are filled, the tops are covered with burlap held in place by metal hoops. Some growers prefer to ship in barrels closed with wooden ends. Some of the new potatoes are graded and packed for shipment in bean hampers, while others are shipped in burlap bags (Fig. 94).

The United States Department of Agriculture [1] gives specifications for grading potatoes in five grades: U. S. Fancy, U. S. No. 1, U. S. Commercial, U. S. No. 2, and Unclassified. Briefly, the fancy grade must be of one variety, firm, mature, bright, free from dirt, well shaped, and free from frost, sunburn, or other mechanical injury and of injury resulting from diseases or insects. The size should be stated, but must not be less than 2 inches in diameter.

The U. S. No. 1 grade must be free of the same general defects as the fancy grade, but the sizes may be smaller, a minimum diameter of $1\frac{7}{8}$ inches for round varieties and $1\frac{3}{4}$ inches for the long varieties being permissible.

The U. S. Commercial grade shall consist of potatoes which meet the

[1] U. S. Dept. Agr. B. A. E. Mimeograph, *United States Standards for Potatoes*, Effective April 6, 1936.

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FIG 94. A popular method of grading and packing Irish potatoes in the South.

requirements of the U. S. No. 1 grade, except for increased tolerance for specified defects.

The U. S. No. 2 grade must also be generally free from mechanical injury and the major defects to be avoided in the other two grades, but may have a minimum diameter of 1½ inches.

Unclassified shall consist of potatoes which are not graded in conformity with any of the foregoing grades.

Detailed specifications and tolerances for all grades are given in the reference cited in the footnote.

MARKETING THE CROP. Early potatoes are sold as a perishable crop, moving from the field direct to the retailer by trucks, or loaded into freight cars and shipped immediately. Storage is risky on account of the immaturity of the product and hot weather. Some of the larger producing districts are visited by buyers who purchase the potatoes f.o.b. the grower's shipping point. Some sell through local exchanges or associations of growers. Few, however, sell on consignment unless other offers are very unsatisfactory. In fact, methods of marketing the

early crop of Irish potatoes follow rather closely those for marketing most other truck crops.

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23

LETTUCE

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CLASSIFICATION, ORIGIN, AND HISTORY. Lettuce (*Lactuca sativa*) belongs to the sunflower or *Compositae* family. It is closely related to the wild lettuce *L. scariola* — in fact, so closely related that the two species cross readily.

The three most commonly grown botanical varieties or types in the United States are: (1) Leaf or cutting lettuce, var. *crispa;* (2) head lettuce, var. *capitata;* and (3) cos or romaine, var. *longifolia.*

Lettuce is not new when compared with other vegetable crops. This is evident from historical references which relate that lettuce appeared at the royal tables of the Persian kings more than 550 years before the birth of Christ.

SCOPE AND IMPORTANCE. Lettuce is one of the most important vegetables. It is the most popular salad crop, is grown in most home gardens, and is widely distributed as a commercial crop in practically

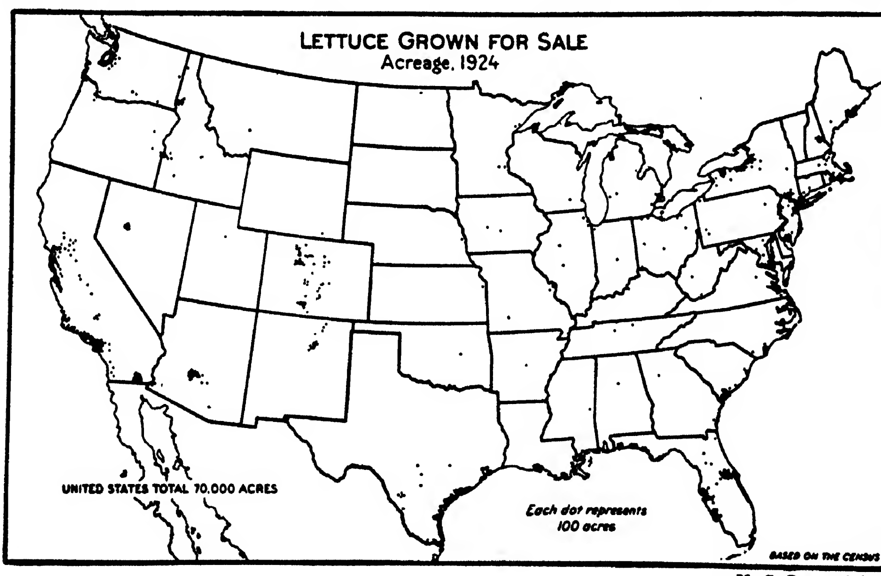


FIG. 95. Acreage and distribution of lettuce grown for sale.

all sections of the United States. Because of the great increase in acreage and the wide distribution of the crop, head lettuce is found on the market every month during the year.

The acreage, yield, production, and value of lettuce grown for shipment in the South and other leading states are shown in Table 40 and Figure 95.

TABLE 40. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF LETTUCE IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

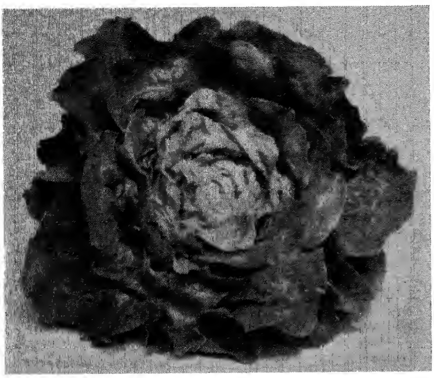
STATES	ACREAGE	YIELD PER ACRE	PRODUCTION[1]	PRICE PER CRATE	FARM VALUE	CARLOT SHIPMENTS[2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Crates	1,000 crates	Dollars	1,000 dollars	Cars	By months
North Carolina . .	1,244	87	108	1.19	129	252	Apr., May
Florida	1,164	240	279	1.25	348	568	Dec., Jan.
South Carolina . .	407	138	56	1.50	84	154	Mar., Apr.
Texas	300	67	20	.95	19	30	Feb., Mar.
Virginia	200	170	34	1.53	52	12	May
Other States							
California	104,053	117	12,205	1.63	19,786	34,088	Apr.–Dec.
Arizona	29,823	95	2,826	1.60	4,510	8,119	Dec.–Apr.
Colorado	6,673	97	647	.88	568	972	Aug., Sept.
New York . . .	5,243	229	1,201	.88	1,062	2,244	July–Sept.
Total (average) for the 15 leading states	157,306	121	19,059	1.48	28,106	48,389	Jan.–Dec.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalents, but excludes motor-truck shipments.

CLIMATIC REQUIREMENTS. Lettuce thrives best at a relatively cool temperature. For that reason, it is grown principally as an early spring, fall, and winter crop in the South. It is only in the most northern states, at high altitudes in the West, and near the coast in California, Oregon, and Washington that it can be grown as a summer crop. Ample sunlight, uniformly cool nights, and plenty of moisture in the soil are essential to well developed solid heads in varieties of the heading types. High temperatures are conducive to early seed stalk development and inferior quality. In a section of North Carolina, where lettuce is grown successfully, the average monthly rainfall for the growing season,

February, March, April, and May, was 3.25 inches. The average temperature for the growing season in the same region was 58.7° F. These records cover a period of 60 years, ending with 1930.



Associated Seed Growers, Inc

FIG 96. Big Boston, a better type variety of lettuce.

Job 1. Selecting Varieties and Seed

VARIETIES. Most seedsmen list a large number of varieties of lettuce and a larger number of variety names. It is too common a practice to give more than one name to the same variety. Although an effort has been made in recent years to standardize variety names, there is yet room for improvement. Morse states that he has a list of about 1,100 names, while the number of actually distinct varieties, allowing for every difference, however slight, is about 150. He states further that a list of 22 varieties covers practically all the varieties used in any quantity in America. The 10 leading varieties in the list of 22 are: New York (Wonderful); Big Boston (Fig. 96); Black Seeded Simpson; Grand Rapids; Hanson; Prize Head; White Boston (Unrivaled); Early Curled Simpson or White Seeded Simpson; Iceberg; and White Paris Cos (Fig. 97).

The brief parallel descriptions shown in Table 41 give some of the distinguishing characteristics of the leading varieties grown in the South.

Wyatt Seed Co

FIG. 97. Heads of White Paris Cos, a variety of the Cos type.

SECURING SEED. The importance of securing good seed cannot be overemphasized. The success or failure of the crop is determined to

a large extent by the seed. Each grower, therefore, should be satisfied with none but the best. The seed supply should come only from a reliable seedsman, one who has established a reputation for his integrity and whose stocks have given good results in tests and in commercial plantings. The best seed may cost slightly more than an inferior grade, but this slight increase in cost is of minor importance when compared with the loss that may result from the use of inferior seed.

TABLE 41. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF LETTUCE

VARIETY	CHIEF USE	SEASON	HEAD			OUTER LEAVES	
			Size	Type	Solidity	Color (green)	Margin
Big Boston	home, local market shipping	early mid-season	medium large	butter head	soft	medium, tinged brown	undulate
Black Seeded Simpson	home	very early	large	crisp head	loose, non-heading	light	undulate-fringed
Grand Rapids	home, forcing	early	large	crisp leaf	loose, non-heading	light to medium	heavily fringed
Hanson	home, local market	mid-season	medium	crisp head	medium firm	light	fringed
Iceberg	home, market, shipping	late mid-season	medium	crisp head	medium firm	tinged brown	fringed
New York (Wonderful)	home, market, shipping	mid-season	large	crisp head	firm	bright	curled
Prize Head	home, shipping	very early	medium	crisp leaf	loose	brown predominates green	fringed
White Boston (Unrivaled)	home, market, shipping	early mid-season	medium	butter head	soft	light to medium	undulate
White Paris Cos (Trianon)	greenhouse, market	mid-season	medium	cos	medium	medium	undulate

Job 2. Preparing the Soil

SOIL PREFERENCES. Lettuce is grown on a wide variety of soil types. The largest commercial acreages are on muck, sandy loam, and silt loam soils. The preference for the early crop is a fertile sandy loam, while the later crops are grown most extensively on mucks and loams.

PREPARING THE SEEDBED. The kind of soil and the climatic conditions govern somewhat the time for plowing. Fall plowing is not desirable in the South because of the loss that may result from soil erosion and by leaching out of plant nutrients where the soil does not freeze.

Plowing should be done as early as the condition of the soil will permit, but in no case when it is too wet. The preparation is completed by means of a disk or a spike-tooth harrow, followed by a plank drag or a Meeker harrow. On land that does not drain quickly, beds are thrown up about 5 feet wide with a one-horse turning plow and dragged off flat. The land should be thoroughly prepared. Lettuce is a comparatively shallow-rooted plant, and, for that reason, it responds to carefully prepared soil in which the roots can develop to best advantage.

Job 3. Manuring, Fertilizing, and Liming

Since rapid growth is essential to crispness and high quality, there must be a liberal supply of readily available plant nutrients in the soil at all times.

MANURING. Where it can be obtained at a reasonable price, heavy applications of stable manure, 20 to 30 tons per acre, will give excellent results on mineral soils. It should be broadcast on the land at least 4 weeks before the time of planting. If stable manure is not available, humus can be supplied by growing green-manure crops such as cowpeas and soybeans.

FERTILIZING. The commercial fertilizer used should be of high quality, analyzing about 4 to 5 per cent nitrogen, 7 to 8 per cent phosphoric acid, and 5 to 6 per cent potash. The rate of application may vary from 1,000 to 2,000 pounds per acre depending upon the fertility of the soil and whether any manure is used. The complete fertilizer should be applied when the soil is prepared. In addition to the complete fertilizer, a side dressing of a readily available form of nitrogen such as nitrate of soda should be applied at the rate of 150 to 200 pounds per acre as soon as the plants start growth after they have been set in the field.

LIMING. Experimental results indicate that lettuce does not thrive on a highly acid soil. A soil reaction between *p*H 5.5 to *p*H 6.5 is satisfactory. If the soil is more acid than *p*H 5.5, lime should be applied.

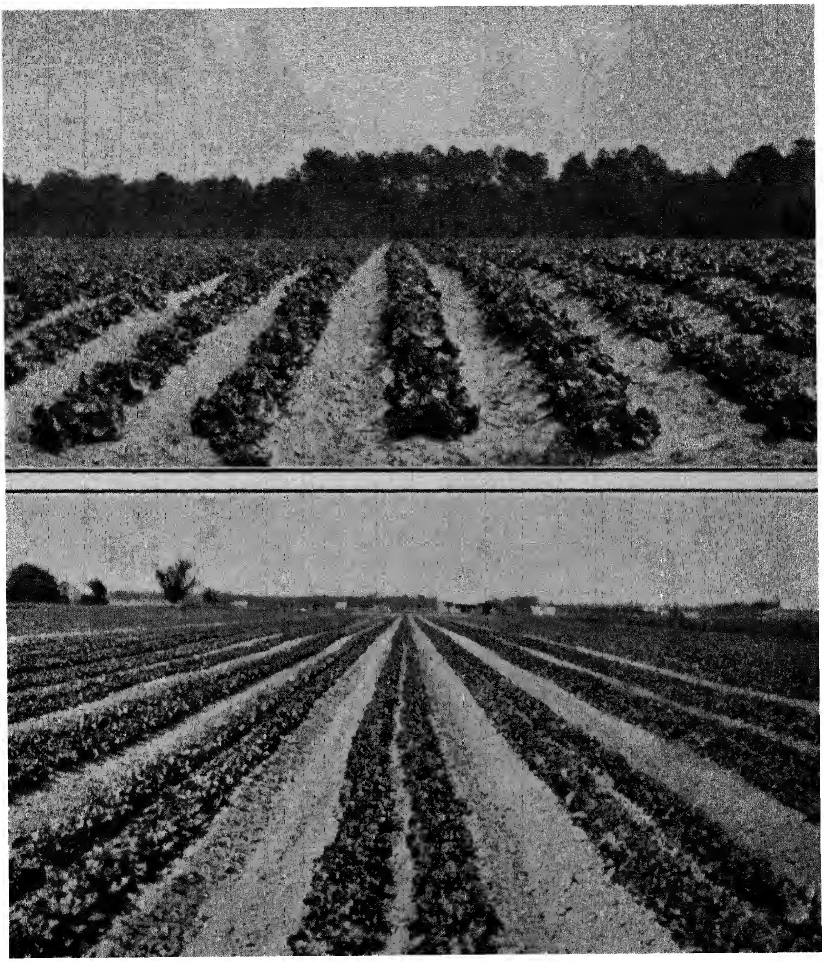


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FIG. 98 Fields of lettuce showing the 1-row and 2-row systems of planting.

Job 4. Seeding and Transplanting

SEEDING AND GROWING PLANTS FOR TRANSPLANTING. A common practice in the South for the extra early spring crop is to grow the plants under cloth or glass sash protection for transplanting to the field. The soil in the seedbed should be prepared carefully and should be made reasonably fertile by thoroughly mixing with the soil 2 to 4 pounds of a standard complete fertilizer per 100 square feet. Thoroughly

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FIG. 99. Four-row lettuce planter in operation.

rotted manure, supplemented either with superphosphate or bone meal, may be used in place of complete fertilizer.

One-half pound of good seed sown thinly on a well-prepared seedbed should produce enough strong, healthy plants to set an acre, but 1 pound of seed for an acre is more commonly used. The seed should be planted in an area covering at least 300 square feet. Very good results can be obtained by making the beds 12 feet wide and covering them with muslin or tobacco cloth stretched over a ridge pole supported on posts through the center of the bed. For the winter or extra early spring crop it will take 8 to 10 weeks to produce plants large enough to be transplanted.

Great care should be exercised in watering and ventilating the plant beds to prevent loss from damping-off, a disease that causes the plants to rot off at the ground.

PLANTING IN THE FIELD. For the winter or spring crop which is ready for market in April or May, the plants are set in the field late in January or early in February. For a fall crop, the plants should be

ready to set out between September 15 to October 10. For the early spring crop, it is generally recommended that two or three different plantings of seed be made in order to insure having plants of proper size for setting in the field in case of a mild winter. When the plants are transplanted to the field, they should be lifted carefully from the soil and planted in the field, so that the tap roots are set straight in the soil. The plant should not be set deeper than it grew in the bed. All spindling and diseased plants should be discarded.

There are several different systems of planting. On poorly drained land, the 4- or 6-row raised bed system is used. The beds are thrown up 5, 6, or 7 feet wide, respectively, with a turning plow, and are dragged off flat. The beds are $2\frac{1}{2}$ to 3 feet apart. Rows are laid off on the beds 12 inches apart with a 4- or 6-peg marker and the plants set 12 inches apart in the row. The 2-row ystem is used for lighter soils and is similar except that the beds are narrower and two rows only are marked off on each bed (Fig. 98). The 1-row system is gaining in favor because it requires very little hand labor after the plants are set (Fig. 98). The work is done largely by horsepower with cultivators and sweeps. The rows should be spaced 30 inches apart and the plants set 10 to 12 inches in the row.

Lettuce is sometimes sown directly in rows in the field at the rate of 2 to 3 pounds per acre and thinned to the desired stand rather than transplanted from the seedbed. Planting is usually done by single-row horse-drawn planters, while multiple-row, tractor-drawn planters are

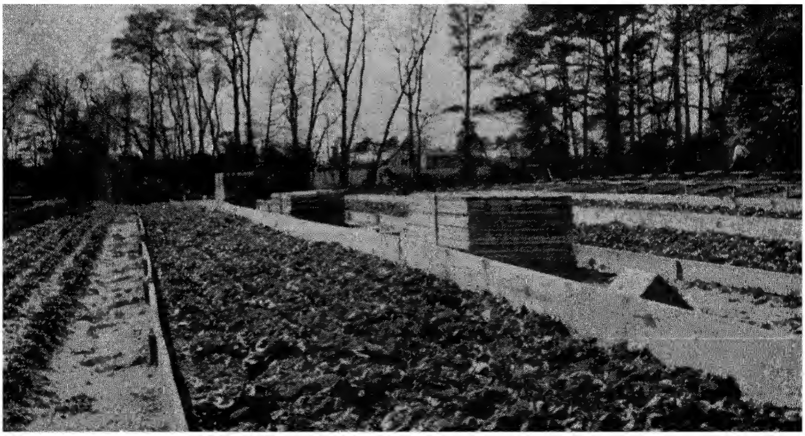

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FIG. 100. Cold frames used for producing winter lettuce.

used in some sections (Fig. 99). In severe weather, however, there is danger that the small plants will winter kill.

Cold frames are often used for growing winter lettuce. The standard widths of the beds are 16 feet for double frames and 9 feet for single ones (Fig. 100). A width of 3 feet is sufficient for passageways between the frames. Any desirable length may be used, although a length of 100 feet is usually considered convenient for heating, irrigating, and removing covers. Covers are made of cotton cloth or glazed sash. Heavy domestic cotton, 3 yards to the pound, is a good cloth for this purpose. Where sashes are used, the beds are usually 11 feet wide and built so that the sashes run north and south.

Job 5. Cultivating and Thinning

CULTIVATING. Shallow cultivation at sufficiently frequent intervals to keep down weeds and to provide a light mulch is recommended. Lettuce plants have comparatively small root systems and most of the small roots are near the surface. For that reason, cultivation deeper than 2 or 3 inches will break off many roots and cause serious injury to the plants. Cultivator attachments which cut the weeds off just below the surface and leave a shallow mulch are usually more satisfactory than cultivator teeth or narrow shovels. If the soil is free of weeds and a mulch is present, nothing will be gained by additional cultivation until more weeds appear and there is need for a mulch.

THINNING AND WEEDING. When the seed is sown directly in the field or when the plants are too thick in the plant bed, it will be necessary to do some hand thinning. In the field the plants should be thinned to stand 10 to 12 inches apart in the row, and in the plant bed far enough apart so that they will not become weak and spindling before time to set them in the field. The plants should be thinned as soon as the second set or first true leaves are formed.

It will be necessary to do some hand weeding between the plants in the row. This may be done effectively with the hands in loose soil or with a hand hoe.

Job 6. Controlling Diseases and Insects

DISEASES. **Tip-burn** is one of the most prevalent and serious diseases of lettuce. It is characterized by a browning and later dying of the marginal tissues of the leaves. It seems to be due to an excessive accumulation of the products of respiration. Plants making very rapid

growth appear to be most susceptible to the disease. Factors which tend to check the rate of growth at maturity serve to reduce the amount of injury but no satisfactory control has been found.

Lettuce drop is the common name of a disease caused by *Sclerotinia libertiana* and *S. minor* fungi which induce wilting and sudden collapse of the outer leaves. Soil disinfection with formaldehyde solution is a satisfactory control on a small area. It should be used at the rate of a gallon of formaldehyde solution (1 part of commercial formaldehyde in 100 parts of water) to a square foot. Crop rotation also is recommended.

Bottom rot is a common disease that is most prevalent during damp weather, and is caused by the fungus *Corticium vagum*. Varieties that have a spreading habit of growth are most commonly infected. The use of an organic mercury dust (ethyl mercury phosphate or Improved Ceresan) dusted under the leaves should check the spread of the disease.

Mosaic is a virus disease characterized by a mottling of the leaves and stunting of the plants. The disease is spread by sucking insects such as aphids; therefore, a special effort should be made to control these insects.

Downy mildew, caused by *Bremia lactucae*, is characterized by a distinctly visible downy or velvety growth upon the affected surface. This disease is not of importance generally, but in some localities it causes considerable injury. Wild lettuce is a host for the organism that causes downy mildew. Eradication of this plant, therefore, is helpful in the control of the disease. Crop rotation also is recommended.

INSECTS. Aphids are the most important insect pests of lettuce. The control measures are nicotine dust and nicotine spray. A 3 per cent dust is recommended. It can be mixed according to Table 16, page 137. The nicotine sulfate spray is made by mixing ½ pint of 40 per cent nicotine sulfate solution with 50 gallons of water. Two and a half pounds of potash fish-oil soap should be dissolved in part of the water and mixed with the spray to help spread it on the foliage.

Job 7. Harvesting, Processing, and Marketing

HARVESTING. Leaf lettuce is harvested for home use as soon as the leaves are large enough. For local market, the whole plant is harvested when it is well developed yet not sufficiently advanced for the leaves to become tough and to acquire a bitter flavor.

The home gardener sometimes harvests head lettuce before the heads become very firm. For market, however, the plants should be harvested when the heads become as hard as existing weather conditions will

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FIG. 101. Lettuce being graded and packed in the field

permit but before the seed-stalk begins to develop. Immature heads are spongy and will not withstand the process of marketing.

Lettuce is cut usually with a sharp knife of convenient size. Head lettuce is commonly cut at or just below the surface of the ground, and all soiled and diseased leaves removed before packing. Where lettuce drop is serious, the head should be cut above the leaves that come in contact with the soil. This will aid in preventing the spread of the disease spores throughout the package. The crop should never be cut when the heads are wet, as they will rot quickly when packed in that condition.

GRADING AND PACKING. Lettuce is commonly graded and packed in the field (Fig. 101). If the crop is not packed in the field, the heads are placed in lug boxes or large crates and hauled to the packing house. Before being packed, the heads are inspected, and, if necessary, are given additional trimming. They should be carefully graded and packed according to recognized standards. The Bureau of Agricultural Economics has formulated tentative grades, printed descriptions of which can be obtained free of charge from the United States Department of Agriculture.

Most of the crop is marketed in three types of containers, the large western crate, the flat or New York crate, and the hamper. The former

holds 36 to 60 heads, depending upon the size, and the latter 24 medium-sized heads. Most of the Florida, North Carolina, and South Carolina crop is marketed in hampers of 40 to 48 quart capacity which hold about 25 heads of first-grade lettuce.

In packing the heads, the first layer should be placed with the stems down, the second layer with the heads down, with subsequent layers alternating in this way until the container is filled.

STORING. Lettuce may be held in cold storage for a period of 3 or 4 weeks after harvest, if it is in good condition at the beginning of the storage period and is held at 32° F.

MARKETING. Most of the lettuce grown in the principal producing sections of the South is shipped in refrigerator cars to northern markets and sold by commission merchants.

A large portion of the Butter Type or Big Boston is sold on the city markets of the Northeast. There is decreasing demand for Big Boston and a definite preference on all markets for the crisp type of lettuce, such as the variety New York.

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24

ONIONS

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CLASSIFICATION, ORIGIN, AND HISTORY. The onion (*Allium cepa*) belongs to the *Liliaceae* or lily family. There are around 300 widely scattered species in the genus *Allium*, and many of them have the characteristic onion flavor and odor. The onion has been used by man as far back as history records. The cultivated species are probably native to the general area of southwestern Asia. Early settlers introduced the onion to North America.

SCOPE AND IMPORTANCE. The onion, with a farm value in 1935 of $18,077,000, ranked sixth among vegetables in the United States, being exceeded only by Irish potatoes, sweet potatoes, tomatoes, lettuce, and English peas. While grown for home use in every state of the Union, this important vegetable is produced commercially in more or less definite sections of the country, a few of which, including the largest, are in the South. Texas led the entire United States in the production

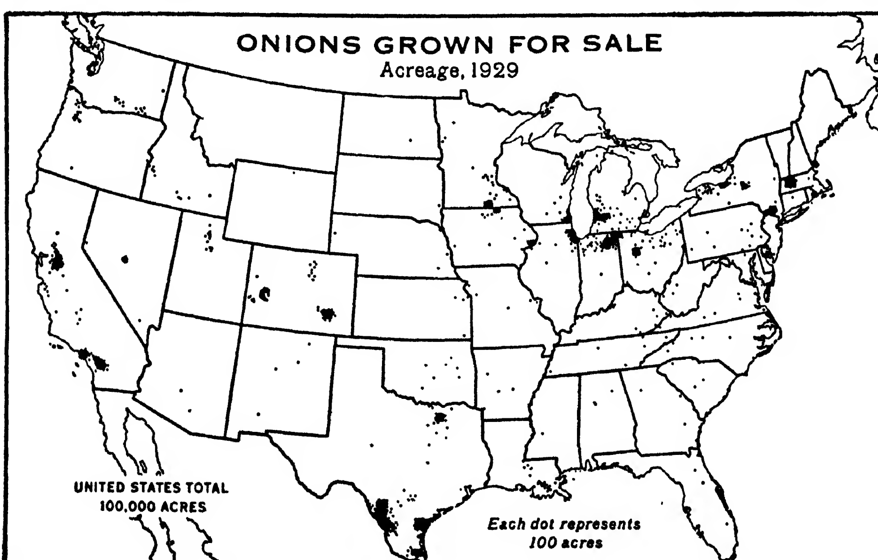

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Fig. 102. Acreage and distribution of onions grown for sale.

of onions from 1929 to 1935, being credited with 25 per cent of the total commercial acreage in the country. Table 42 shows the relative importance of the southern onion-producing states with other heavy producing states (Fig. 102).

TABLE 42. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF ONIONS IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [1]	PRICE PER SACK	FARM VALUE	CARLOT SHIPMENTS [2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	100-pound sacks	1,000 sacks	Dollars	1,000 dollars	Cars	By months
Texas	21,999	91	2,010	1.75	3,308	6,605	Apr.–June
Louisiana	1,291	46	59	1.86	110	81	May–July
Virginia	599	77	46	1.61	74	111	Aug.–Oct.
Other States							
California	8,760	170	1,492	1.21	1,717	3,161	May–July
New York	8,740	235	2,055	1.08	2,215	3,500	Sept.–Nov.
Michigan	8,110	171	1,388	.95	1,324	4,203	Sept.–Nov.
Indiana	7,264	151	1,095	.79	866	3,466	Sept.–Nov.
Colorado	4,923	169	832	.75	602	1,935	Jan.–Mar.
Total (average) for the 23 leading states	86,543	155	13,457	1.11	14,713	32,452	Jan.–Nov.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalents, but excludes motor-truck shipments.

AVERAGE PRODUCTION COSTS. The costs of growing onions vary greatly, depending on systems of culture, seed, fertilizer, irrigation, and other factors. Under the simplest of systems and with the minimum of care, the cost per acre of onions delivered to the car may be as low as $40, but with intensive methods, especially in irrigated areas, such costs may be as high as $160 or more per acre. Compared with some vegetable crops, onions are rather expensive to grow.

CLIMATIC REQUIREMENTS. The onion is adapted to a temperate climate, and is grown in southern Texas and Louisiana during the fall and winter and harvested in the early spring. In Virginia, Kentucky, and all the more northerly sections of the South, they are usually grown in the spring and harvested in early summer.

Onions will often withstand temperatures as low as 25° F., although a report from Texas in 1934 showed that many onions survived a temperature as low as 18° F. To thrive well, onions require a fairly adequate water supply. Around harvest time fairly high temperatures combined with dry atmosphere are desirable, especially for the Bermuda type.

Job 1. Selecting Varieties and Seed

Two dry bulb groups of onions are generally recognized in the United States. One, the American or domestic, includes many varieties; the other, referred to as the European or foreign, contains chiefly the Bermuda, Spanish, and Creole types, all of which are grown more commonly in the South and in certain sections of the West and Southwest than in other regions. These two groups of onions are supplemented by the Egyptian, or top onions, and the multiplier, or potato onions, all of which are grown for green bunching onions.

In selecting a variety, consideration should be given to climate, market, and soil requirements, particularly to the first. The Bermuda and Creole varieties are naturally more adapted to the extreme South because they will mature normally in a shorter day, before the hot weather sets in. All the American types, as well as the Spanish varieties, will not mature in southwest Texas until late June, no matter how early the seed may have been sown the previous fall. Usually, only a small percentage of the crop will be marketable, since the atmospheric and soil temperatures during May and June are not conducive to normal growth.

VARIETIES. In Texas, about 88 per cent of the onions grown are Bermudas, while in Louisiana, the Creole onion constitutes the largest proportion of the onion crop, not over 10 per cent being Bermudas. In Virginia and Kentucky, more varieties of the domestic type are grown. Yellow Globe Danvers, Yellow Strasburg, and Ebenezer or Japanese are all reported as being popular in Virginia. Brief comparative descriptions of varieties grown in various southern sections are given in Table 43.

SECURING SEED. The bulk of Bermuda onion seed is grown in the Canary Islands. The seed of the Creoles is produced mostly in Louisiana, and seed of the remaining varieties comes largely from California and foreign sources. Regardless of the variety being grown, it pays to buy clean seed of high germination and true to type. Good seed is rarely cheap, but the product of good seed will usually repay the extra price many times over.

TABLE 43. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF ONIONS

Variety	Chief Use	Season	Bulb				
			Size	Shape	Color	Pungency	Keeping quality
Crystal Wax	home, shipping	very early	medium	flat	white	mild	poor to fair
Ebenezer (Japanese)	growing bulbs and sets	second early	medium	flat	yellow	pungent	good
Prizetaker	home, shipping	very late	very large	globe	light yellow	medium pungent	medium to good
Red Creole	home, storage	second early	small	deep flat, rounded	light bronze, pink	pungent	excellent
Sweet Spanish (Valencia)	home, shipping	very late	very large	globe	yellow	mild	poor to medium
White Creole	home, storage	second early	small	deep flat, rounded	white	pungent	excellent
Yellow Bermuda	home, shipping	very early	medium	flat	light yellow	mild	poor to fair
Yellow Globe Danvers	storage	medium late	medium large	globe	yellow	medium pungent	good
Yellow Strasburg	growing sets	medium late	medium	flat	yellow	medium pungent	good

Job 2. Preparing the Soil

SOIL PREFERENCES. Good onion land should be friable, fertile, well supplied with humus, and well drained. A heavy soil which will bake after rains or after irrigation is not desirable. Clay, alluvial, and sandy loams, as well as mucks, are often used for onions. Of the four types the last two are preferable, although they usually need more fertilizer to fulfill the requirements of fertility. In eastern Virginia and in the Winter Garden area of Texas, onions often are grown on sandy loams; while in Louisiana and in the lower coastal belt of Texas, the clay or silt loams are more common.

PREPARING THE LAND. In the far South where growers often raise their own plants in large outdoor seedbeds, it is necessary to prepare two pieces of land, the seedbed and the land where the crop will mature. In either case, early preparation is desirable. The soil should be plowed to a depth of 6 to 8 inches, harrowed, and left in good tilth.

Rough, lumpy ground is not suited to the planting of onion seeds, small plants, or dry sets. In irrigated sections, the land must also be leveled in order to irrigate properly.

Job 3. Fertilizing, Liming, and Manuring

FERTILIZING. The onion with its limited root system responds to good fertilizer practices on almost any soil. Experiments conducted in Texas, Louisiana, and Virginia indicate that on sandy soils phosphoric acid is the most important nutrient. For four seasons at the Winter Garden Substation in Texas, the omission of superphosphate from the fertilizer (6–0–6) resulted in lower yields than where the soil was left unfertilized. In these states nitrogen also is usually desirable, but potash seems necessary only in Virginia, where a complete fertilizer, having a 1–2–1 ratio, is recommended. In southwest Texas, a 1–3–0 ratio is more suited. Amounts ranging from 600 to 1,000 pounds of 5–15–0 in Texas, and 5–10–5 or 4–8–4 in Virginia are recommended. The experiments in these states also show that the fertilizer is best applied before the green or dry sets are planted, rather than later as side dressings. Side dressings of nitrate of soda when the crop is half grown may increase yields in seasons of heavy rains, or where too frequent irrigation is employed. The practice of side dressing with nitrate of soda is common in most sections. Experiments in Texas indicate, however, that side dressings, following an application of complete fertilizer, may actually decrease yields in some instances. However, if a complete fertilizer is not applied before planting, side dressings of nitrate of soda may increase yields slightly. Ammonium phosphate (11–48–0) makes a better side dressing than nitrate of soda, since it supplies the necessary phosphorus. While not so soluble as the nitrate, it is more soluble than most phosphates.

LIMING. The onion thrives best on slightly acid soils (*p*H 6.0 to *p*H 6.5), but it grows poorly on very acid soils. The Virginia Truck Experiment Station recommends lime for onion culture in eastern Virginia. Very acid soils need a ton of hydrated lime or 1⅓ tons of finely ground limestone per acre per year until the acidity of the top soil is sufficiently reduced. One-half ton of lime should suffice on moderately acid soils. After the soil has reached the desired state, only occasional liming is necessary. Few, if any, of the Texas onion soils require lime.

MANURING. Organic matter in the form of either barnyard or green manure should be added to the soil at every opportunity, as it

conserves soil moisture, improves the physical condition of the soil, and tends to retard the loss of available nutrients. Even when well rotted, barnyard manure should be added several weeks before planting. In Texas, growers are resorting more than formerly to green manures, such as cowpeas. Summer legumes alternate well with winter-grown onions and other vegetables. They shade the ground, reduce weed growth, and add an abundance of organic matter to the soil.

Job 4. Planting

The most distinct methods of planting onions include (1) sowing seed directly in the field where the crop is to mature; (2) sowing in a seedbed from which the plants will be later transplanted to the field; and (3) planting sets. A grower may buy these sets, or grow them from seed himself. All these methods are used in the South.

SEEDING. The rate of seeding depends upon the purpose for which planting is done, and the distance employed between the rows. Where the crop is to mature, 5 to 6 pounds is a common rate to plant in rows 12 to 16 inches apart. However, the rate may vary from 1 to 10 pounds; as in some sections very wide spacing is used, and in the others, growers prefer to obtain a thick stand, so that there will be surplus plants to sell at thinning time. For the production of plants in southwest Texas, rates range from 25 to 35 pounds per acre, although experiments now under way at the Texas

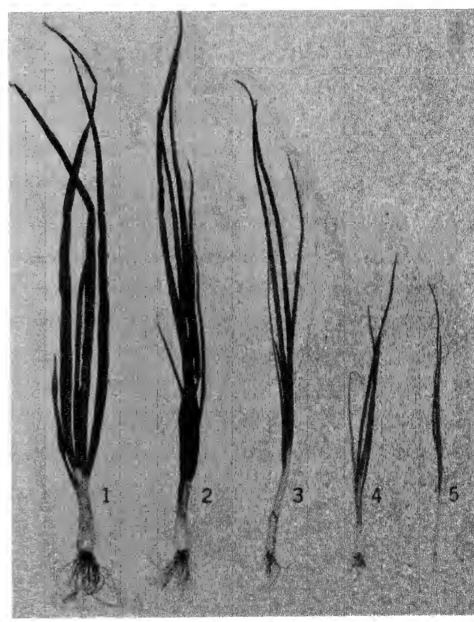

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FIG. 103. Onion plants at transplanting time, ranging in diameter at the neck from over $\frac{9}{16}$ to less than $\frac{1}{8}$ inches. Numbers 1 and 5 should not be used, while numbers 2, 3, and 4 can all be planted. Number 3, which has a diameter of $\frac{1}{4}$ to $\frac{3}{8}$ inch (pencil size) is the most dependable. Number 2 may result in splits, doubles, and seeders; and number 4 will produce lower yields than number 3.

Experiment Station indicate 18 to 20 pounds as preferable. To produce dry sets, 60 to 80 or even 100 pounds of seed per acre are planted, depending on the soil fertility. This practice is more common in the northern sections of the South. The extremely crowded conditions cause the onions to mature when very small. Desirable sets are $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter. Various hand drills and horse-drawn, multiple seeders are commonly used in planting onion seed.

SETTING PLANTS. Only strong, healthy plants should be set. Preliminary reports from the Texas Experiment Station indicate that on the basis of yield small plants are undesirable. When large plants are used there is more danger of splits, doubles, and seedstems in the mature crop, unless the plants are handled very carefully to avoid all unfavorable conditions. The medium or pencil-sized plant is the most dependable one to use (Fig. 103). While it is a common practice to prune the tops back to about half their length, experiments in Louisiana and Texas have indicated that this probably reduces yields and delays maturity.

In spite of the large acreages involved in the irrigated Bermuda onion sections where transplanting is the common practice, all the work is done by hand, fairly cheap, experienced help being available.

PLANTING DRY-SETS. The operation of planting sets is very similar to that of planting seedlings. The chief difference is that the sets are dropped into a shallow furrow about 3 inches apart in the row, and then covered, permitting only the tips to show. The quantity of sets needed for an acre varies with the size of the sets and the planting distances. According to Beattie, the amount usually ranges between 15 and 22 bushels.

PLANTING TIME AND METHOD. In southern Louisiana and southern Texas, seed is usually sown in outside seedbeds during late September and early October. In more northerly sections, growers either raise their own plants in cold frames, or plant directly in the field later, or buy their plants during winter and early spring from sections in the far South. In Virginia, onion sets are planted from January to March, depending on climatic conditions. In all sections early plantings are favored, as they usually result in higher yields, provided they are not too early. Injury from cold is likely to result from planting too early.

Close spacing of the rows, 12 to 18 inches, is common in most irrigated sections, as well as sections where rainfall is abundant. In some non-

irrigated sections of Texas, onions are planted in rows 3 feet apart; these are interplanted with cotton shortly before harvest.

Job 5. Cultivating and Irrigating

CULTIVATING. Because of their slow growth, small stature, shallow roots, and lack of dense foliage, onions more than most vegetables cannot withstand the ill effects of weeds. In practically all sections, the onion crop is cultivated every week or two after the seedlings emerge, or the sets or plants are set out. This operation is continued until several weeks before harvest. Such a practice helps to control weeds, and also loosens the soil after irrigations or rains. All cultivations except the very first ones should be very shallow, as many of the onion roots are close to the soil surface. Cultivating too deeply or too closely to the plants after the crop is well advanced may do more harm than good.

In narrow-row seedbeds, wheel hoes are commonly used for cultivation and weeding. However, in Texas, growers frequently cultivate several rows at once with a light-weight wheel cultivator drawn by one mule.

THINNING AND WEEDING. Thinning is practiced only when the seed has been sown in the location where the crop is to mature. This is expensive and is not resorted to, if it can be avoided. It is usually cheaper to control the stand as much as possible by a lower rate of seeding. In certain sections of south Texas, however, the practice of thinning often pays for itself because of the market farther north for the plants that are removed.

Onions frequently require at least one good hand weeding. Sometimes this can be combined with the thinning operation, but more often it is an entirely separate job.

IRRIGATING. In irrigated sections where the success of the crop depends on proper irrigation methods, the time to apply water is important. Soil, both surface and subsoil, current weather conditions, and age of the crop need to be considered in deciding when to irrigate and how much water to apply. A seedbed is usually irrigated immediately after planting, and then just as frequently as is necessary to maintain a moist condition until emergence occurs. Normally one to three irrigations are necessary after the seedlings have emerged to insure steady growth. Sufficient water should be applied to moisten the soil thoroughly (Fig. 104). Irrigation of onions in Texas is either by the furrow or by the flooding system.

D R Porter, Truck Crops Division, Davis, Calif

FIG. 104. Irrigating Crystal Wax onions planted in single rows on small beds

The seedlings should be irrigated as soon as possible after transplanting. Between this irrigation and harvest time, irrigated onions in south Texas usually receive 5 to 7 additional applications of water, spaced as much as 4 to 6 weeks apart at first. For 2 to 3 weeks before harvest when the onions are bulbing, irrigations may be as often as every week or 10 days, in order to prevent the soil baking around the bulbs, which causes them to be misshapen. Experiments in Texas have shown that over-irrigation of onions should be avoided, since yields may be reduced seriously by such a practice.

Job 6. Controlling Diseases and Insects

DISEASES. The onion is subject to a number of diseases. Not all of these are prevalent in the South, nor in all sections. The most important diseases in the South are discussed here:

Pink root, caused by the fungus *Fusarium malli*, may infect onion plants of any age. Since the disease, especially in the early stages, is confined to the roots and bulb plate, it may go unnoticed for some time. Roots turn pinkish in color, then shrivel and die, and the disease usually reduces yields greatly. Every precaution should be taken to use disease-

free land for the seedbed and the transplanted seedlings, and to obtain plants free from the disease, when they have to be purchased. Where disease-free seedlings are grown on disease-free land, there is no danger of pink root. In addition to this precaution, it is well to combine rotation and proper fertilizer and cultural practices, in order to produce fairly rapid and steady growth.

Neck rot, associated with a species of *Botrytis,* is a rather serious disease in the more northerly sections. Infection occurs at the neck or in the wounds on the bulbs during or following harvest. The disease can be recognized by the grayish mold on the surface of the area infected. Losses may occur in the field, and bulbs often decay while in storage or in transit. Stands in certain sections of Virginia were reduced as much as 80 per cent on one occasion. Control measures for neck rot include proper curing and storing. Bulbs that are well dried, especially at the neck, are less likely to succumb to the disease than those that are not well cured. Temperatures in storage should be kept as nearly 32° F. as possible, and there should be adequate ventilation to maintain a dry atmosphere. The disease can be reduced in the field by planting only healthy sets.

Soft rot reduces stands and causes trouble in storage. Control measures are practically the same as those for neck rot.

Blights. Various organisms attack onions causing diseases commonly called blight. Such troubles often occur during periods of damp weather, and destroy considerable foliage in a brief time. *Macrosporium parasiticum* has been frequently identified with these diseases, but other organisms also have been found. Frequent spraying with Bordeaux mixture may at times control the disease.

INSECTS. **Thrips** is the only important onion insect pest and is discussed on page 142.

Job 7. Harvesting, Processing, and Marketing

HARVESTING. Onions may be harvested either as green-bunch onions or as mature bulbs. An onion is suitable for green bunching from the time it has reached pencil size until it begins to bulb. Such immature onions are commonly harvested in home and market gardens. In the large onion-growing sections, the crop is harvested almost entirely at the mature stage. When 30 to 50 per cent of the tops begin to fall over, growers usually begin to harvest. A small onion plow is frequently used to loosen the bulbs, which are then pulled and thrown in windrows.

In irrigated sections water may be used to soften the ground a day or two before harvesting, which permits the bulbs to be pulled easily. A few days of curing usually follows the pulling in northern sections, or whenever drying conditions are not very satisfactory. In Texas, onions are often pulled, clipped, and shipped the same day (Fig. 105). Care should be taken to avoid sun scalding caused by curing too long in direct sunlight during harvest.

Harvesting begins around March 20 in the extreme South, while growers in Virginia harvest their onions in late June and early July. Yields in all sections vary greatly depending on conditions, but in general range between 100 and 400 bushels per acre.

GRADING. After the tops have been removed, the onions are usually graded into U. S. No. 1 onions, U. S. No. 1 boilers, and culls (Fig. 106). Onion grades depend somewhat on the variety involved, Bermuda, Creole, and domestic onions all being classified on slightly different bases. These grades change slightly from time to time, and it is well to obtain periodically the latest rulings direct from the Bureau of Agricultural Economics, United States Department of Agriculture.

PACKING. In nearly all sections 50-pound open-mesh bags have practically replaced all other containers; however, some of these, such as the folding crate, are still used widely in harvesting operations because

FIG. 105. A field of Bermuda onions being harvested in southwest Texas. Foreground, onions clipped, in crates, and ready for grading; center, onions still being clipped; background, field unharvested.

FIG. 106. Grading and sacking Bermuda onions, using Mexican labor.

of the ease of handling. The 50-pound onion sacks enhance the appearance of the onions in much the same way that a red mesh cloth often adds to the appearance of a basket of peaches.

STORING. Bermuda onions are notoriously poor keepers and are rarely stored for any length of time. Unless the onions have been carefully handled and properly cured and are free from disease, storage is likely to lead to disappointment and loss instead of gain. Under any storage conditions there are always considerable handling, repacking, and shrinkage. Cold storage at slightly above 32° F. with a dry atmosphere and thorough ventilation is the only method which will normally give satisfaction, and then bulbs must be cured properly and free from disease. Actual freezing must be avoided.

MARKETING.[1] The problem of marketing is a very specialized one. The average grower, however, disposes of his crop at or soon after harvest. In Virginia and Texas, dealers, jobbers, shippers, and others are usually on hand at harvest time to buy onions for cash provided they pass the federal-state inspection satisfactorily. In the large onion-producing sections, federal agencies often publish daily reports of the numbers of cars being sold, the range of prices, and the general conditions

[1] U. S. Dept. Agr. Farmers' Bulls. 1283 and 1325.

of the market. Prices vary greatly from year to year, however, the grower who consistently produces onions for a period of years, and at the same time practices efficient methods, usually realizes profit.

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PEAS

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CLASSIFICATION, ORIGIN, AND HISTORY. The garden pea (*Pisum sativum*) is a cool-season, hardy, annual, tendril-climbing plant, belonging to the *Leguminosae* family. It is grown for edible green seeds, although there is one kind which is grown in European countries for the edible pods, as are string beans. In the South, peas are generally referred to as English peas. The pea originated in Europe and Asia, and the plant was commonly grown in the gardens of the ancient Romans and Greeks.

SCOPE AND IMPORTANCE. The consumption of peas in the United States has been increased greatly during recent years. The shipment of green peas for market has increased rapidly. Texas and Florida commence light shipments of green peas in December and the movements from these states are practically completed during February. Some light shipments are made during March from Louisiana and Mississippi, and the bulk of the commercial product from South Carolina and Mississippi moves during the latter part of April and early May, followed with rather heavy shipments by North Carolina and Virginia during the latter part of May and early June. Table 44 shows the relative importance of the leading states in acreage, production, farm value, and carlot movement.

The production of peas in the South is almost exclusively for use in the fresh state. With the exception of a small acreage in Virginia, the southern states do not grow peas for canning; therefore, cultural methods will not be given on growing peas for canneries.

AVERAGE PRODUCTION COSTS. The pea is comparatively inexpensive to produce in most sections of the South. The major cost items are: (1) Seed, (2) fertilizer, (3) harvesting labor, and (4) containers. Accurate cost of production figures are lacking; but depending upon yields, the production cost per acre usually varies from $30 to $75. The average cost of production per bushel is quite high because of the low average yield per acre as shown in Table 44.

TABLE 44. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF GREEN (MARKET) PEAS IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION[1]	PRICE PER BUSHEL	FARM VALUE	CARLOT SHIPMENTS[2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
North Carolina	3,799	71	268	.82	221	358	May, June
South Carolina	3,214	44	143	.99	141	168	Apr., May
Florida	3,036	69	210	1.41	297	272	Nov.–May
Mississippi	2,069	67	139	1.09	152	166	Apr., May
Virginia	1,756	60	105	.88	92	153	May, June
Louisiana	1,213	55	67	1.70	114	1	April
Texas	729	41	30	1.27	38	9	Dec.–Feb.
Other States							
California	53,780	71	3,826	1.48	5,647	4,003	Jan.–Dec.
Colorado	8,284	80	660	.99	622	509	July-Sept.
New York	6,207	80	495	1.25	619	371	June, July
New Jersey	3,457	65	226	1.13	255	7	June
Total (average) for the 18 leading states	94,967	75	7,151	1.29	9,170	7,245	Jan.–Dec.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.
[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

CLIMATIC REQUIREMENTS. The pea is a cool-season crop and thrives best under cool weather conditions and when ample moisture is available. In the early sections of Texas and Florida, the crop is brought to maturity during the winter months and in later sections during late winter and early spring. The young plants will tolerate considerable cold and light frosts, but the flowers and green pods are often injured by heavy frost. If the crop is planted late, maturity takes place when the temperatures are too high for optimum growth and yields. Therefore, it is important to plant late enough to avoid freezes, yet sufficiently early to mature the crop before hot weather.

Job 1. Selecting Varieties and Seed

VARIETIES. There are many varieties of peas offered by the seedsmen, and most of these varieties possess merits. When varieties are selected for home use, the following points should be considered: (1) Adaptability to the section; (2) days required to reach maturity,

that is, whether early, medium, or late variety; (3) productivity; and (4) quality. When a variety is selected for market purpose, preference of the market trade must be given consideration, as well as the adaptability of the variety to the section. There should be developed for the South, adaptable, high-quality varieties, possessing a high degree of resistance to the serious diseases which often cause many almost complete failures.

Among the most popular commercial varieties now being grown are Laxton's Progress, Laxtonian, and Thomas Laxton (Fig. 107). Other varieties less extensively grown are Alaska, Nott's Excelsior, Gradus, Dwarf Telephone, Perfection, and Little Marvel. The Bliss Everbearing, Alderman, and Asgrow 40 are varieties resistant to Fusarium wilt but have not yet been grown extensively in the South. For home gardens, one or more of the varieties mentioned above are usually planted. It is estimated that 85 to 90 per cent of the peas grown by the home gardeners of Louisiana are of the variety Creole. This is a very vigorous, cold- and heat-resistant, smooth-seeded variety which offers possibilities to southern breeders for developing new varieties. Excellent breeding work is being done at the agricultural experiment stations of Wisconsin and Maryland, where disease-resistant canning varieties are being perfected.


Associated Seed Growers' Inc

FIG. 107. Plant characteristics of the Thomas Laxton variety.

A brief description of the important varieties of peas is given in Table 45.

SECURING SEED. Since it is impossible to identify definitely varieties of peas by the seed alone, growers should procure their seed from reliable sources. The seed should be from the crop of the previous

Table 45. Outstanding Characteristics of the Principal Varieties of Peas

Variety	Chief Use	Season	Average Plant Height in Inches	Pod			
				Size in inches — length, breadth	Shape of pod	Color of pod	Number of peas
Alaska	very early market, canning	very early	24–30	2 by $\frac{1}{2}$	straight	light green	4–7
Dwarf Telephone	home, late market	late	24–32	4 by $\frac{3}{4}$	slightly curved	medium green	6–8
Gradus	home, market	early	28–36	3 by $\frac{5}{8}$	straight	light green	6–8
Laxtonian	home, market, shipping	early	13–15	$3\frac{1}{4}$ by $\frac{5}{8}$	curved	medium green	6–8
Laxton's Progress	home, shipping	early	14–16	$3\frac{1}{2}$ by $\frac{3}{4}$	pointed	medium green	6–9
Little Marvel	home	early	16–18	$2\frac{3}{4}$ by $\frac{5}{8}$	straight	medium dark green	6–8
Nott's Excelsior	home	very early	14–16	$2\frac{1}{2}$ by $\frac{1}{2}$	straight	medium green	6–7
Perfection	home, canning	late midseason	24–28	$3\frac{1}{2}$ by $\frac{5}{8}$	slightly curved	medium green	7–9
Thomas Laxton	home, market, shipping	early	20–30	$3\frac{1}{4}$ by $\frac{5}{8}$	straight	dark green	6–8

year. On account of diseases, the pea-seed producing areas are found usually in the semiarid West and on the Pacific Coast, and experiences of growers of the South indicate that it is essential to secure seed from such sections.

Job 2. Preparing the Seedbed

SOIL PREFERENCES. Peas are grown on a variety of soils in the South. The sandy loams with clay subsoil are generally preferred. In Florida, the well-drained hammock soils are considered the best types for peas, while in Texas and Louisiana, they are planted on the heavy loam soils. Ample drainage is essential, especially in those sections where heavy rainfall occurs during the early part of the growing season. If well drained, some of the heavier soils, such as the clays and loams, produce higher yields than do the more porous, sandy soils.

Regardless of the soil type, humus or organic matter is very essential

in the satisfactory production of peas. Experiences indicate that soils which have previously been improved by applications of barnyard manure or by growing and turning under cover crops are best for growing fine crops of peas. Studies at the Maryland Experiment Station indicate that soil organic matter was the factor most positively correlated with plant growth, yield, and nodule formation.

The garden pea, like most legumes, prefers a slightly acid soil, but will not tolerate excess soil acidity. Most authorities in the South maintain that garden peas should be grown in a soil with a *p*H range of 5.8 to 6.5. While lime is very desirable for strongly acid soils in the South, it should be remembered that liming will not solve other production problems, and that the use of excess quantities of lime would be very undesirable. On some soils of the South that are limed too heavily, peas and other vegetable crops fail to grow and become chlorotic because of lack of available manganese. Some of the southeastern sandy soils are deficient in magnesium, and, on such soils, a magnesium limestone should be used.

PREPARING THE SOIL. Very close attention should be given to the matter of soil preparation because poor growth and low yields often are traceable to lack of thorough soil preparation. During the fall months, the soil should be thoroughly disked to cut up and incorporate any cover crop or other plant residues, to hasten their decomposition. The land should later be plowed deeply; and just before preparing the beds for planting, further disking or harrowing should be done.

FERTILIZING. In most sections of the South, commercial fertilizer is essential in growing peas. On some very rich fertile virgin soils of Texas, little or no fertilizer may be needed, while in some of the less fertile sections of the South, growers use 800 to 1,000 pounds per acre of a high-grade fertilizer. Experimental results are limited on the fertilization of peas in the South, but the following analyses and amounts per acre are used by growers in the several states: Florida, 500 to 800 pounds of 4–8–3; South Carolina, 600 to 1,000 pounds of 4–8–4 or 5–7–5; North Carolina, 700 to 1,000 pounds of 3–8–6; and Virginia, about 1,000 pounds of 6–6–5. This fertilizer is usually applied in the drill and thoroughly mixed with the soil before the beds are made, in order to prevent the seed from coming in direct contact with the fertilizer which would seriously interfere with germination. In addition to the complete fertilizer, a top dressing of 50 to 100 pounds of quickly available nitrogen fertilizer, such as nitrate of soda or sulfate of ammonia, is

used by some growers, just before or very soon after the peas come up to a good stand.

Certain coastal plains soils of the Atlantic seaboard are quite generally deficient in magnesium and manganese. Where these elements are deficient, basic slag is an excellent material to use if the soil needs liming, because basic slag contains these two minor elements in addition to calcium. The iron oxide which basic slag also contains is helpful on some of the very light sandy soils of the area. A very cheap source of magnesium is dolomitic (or magnesium) limestone. Soils deficient in these minor plant nutrients should be given a special fertilizer containing the minor elements needed, unless these have been supplied through the use of basic slag or magnesium limestone.

INOCULATING. The garden pea, as other legumes, requires inoculation with specific legume bacteria. The nodule-forming bacterium is the same for garden peas, vetch, and Austrian peas. Where the soil has not been inoculated in previous years by growing one or more of these crops, artificial inoculation of the seed should be practiced. In a number of demonstrations in South Carolina, yields have been increased 50 to 100 per cent by inoculation, while in other demonstrations no increase in yields was obtained.

Job 3. Planting and Cultivating

It is not advisable to plant peas before October 15 in the Winter Garden section of Texas. Planting dates for the different sections of the South vary, therefore, from October 15 as the earliest for Texas to March 1 for the Eastern Shore section of Virginia. Plantings made later than the earliest practicable dates usually mature in less time but invariably produce lower yields, apparently on account of high temperatures.

Under average conditions, it seems that about 2 bushels of seed per acre should be used. A seedbed approximately 6 inches in height for most sections should be thrown up some time in advance of planting, so that it may become firm. Lower beds can be used on well-drained soils.

When peas are planted in single rows, the distance between rows varies from 2 to 3 feet; when double rows are used the beds are about 4 feet apart, the two rows on each bed being 8 to 12 inches apart.

Planters and drills are used in planting the seed, but in some cases the seeds are planted by hand. The usual depth of planting is 1 to 2 inches.

CULTIVATING. Since the pea develops rapidly, no great amount of cultivation is necessary. The cultivations should be shallow to avoid

destroying too many of the fibrous roots, and only frequent enough to destroy weeds and grasses.

STAKING. With few exceptions, no support is given the vines, in the commercial pea sections. Cane or small stakes, set at intervals in the row, and overlapping near the top, are generally used by home gardeners. Wire netting supported by stakes between double rows or to the side of single rows is sometimes employed. Inexpensive twine also is used, three to five parallel lines being fastened to laths or small stakes spaced 6 to 10 feet apart along the rows.

Job 4. Controlling Diseases and Insects

DISEASES. The most important pea diseases found in the southern states are: (1) Root rots, (2) Fusarium wilt, (3) Aschochyta blight, (4) mosaic, (5) bacterial blight, (6) downy mildew, and (7) powdery mildew. From a practical standpoint, the only feasible control measures are: (1) Use of disease-free seed, and (2) crop rotation. Bacterial blight and Aschochyta blight are seed-borne diseases; the wilts also are seed-borne to a slight extent. For the control of these seed-borne diseases, disease-free seed should be obtained from the semiarid West and Pacific Coast states when available. The wilt organisms are reported to live almost indefinitely in the soil, and the only satisfactory control, therefore, is the use of resistant varieties. There is no definite control for the root rots which are very common in the South.

INSECTS. The following insects attack peas in the South: (1) Pea aphid, (2) thrips, (3) red spider, (4) seed corn maggot, and (5) nematode. Generally, it has not been found economical to control these insects. The only control for nematodes is to practice a rotation, and to avoid growing susceptible crops on the land.

The pea aphid (*Macrosiphum pisi*) is the worst pest in some sections. Dusting with a 3 per cent nicotine dust, if done before heavy infestation becomes prevalent, is recommended. However, if the infestation is heavy, the value of the control will probably not compensate for the expense of the material and the cost of applying.

Job 5. Harvesting, Processing, and Marketing

HARVESTING. Harvesting of green peas in the South is done entirely by hand. Two or three pickings are usually necessary. The vines should be handled carefully if the yield and quality of the later pickings are not to be impaired. In some sections the peas are picked

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Fig 108. Pea harvesting scene, employing low-price labor.

and placed directly into the container in which they are to be shipped, while in other sections field crates or picking containers are used. Common labor is employed to do the harvesting, but it is desirable to have a competent foreman or supervisor in charge (Fig. 108).

In a great many cases, too little attention is given to harvesting peas at the proper stage of growth for a product of highest quality. It has been shown that sucrose is probably the most important constituent determining sweetness in garden peas. They should be harvested, therefore, when the total weight of sucrose is at its highest, because immediately following that stage there is a rapid decrease in the percentage of sugar and an increase of starch. The pods should be picked when fully green and well developed, and before the peas start hardening.

GRADING. Grading of peas has been limited, but in recent years some interest in this practice has developed. As the peas come from the field to a central packing shed, they are placed in a grading machine which has a blower attachment to remove the trash. Laborers standing along each side of the belt pick out defective and exceptionally small pods as the peas pass by. The machine used for this purpose is similar to the one used for grading snap beans and cucumbers.

Compulsory grading in the South does not prevail; however, some shippers meet the grade requirements of the United States Department of Agriculture.

PACKING AND LOADING THE CAR. The bushel hamper is generally used throughout the South (Fig. 109), although during the past few years the flat crate has come into use. Since peas are rather perishable and heat easily, a shallow or flat container is desirable. The container should be well filled, since slack pack detracts materially from the package and is often the cause of poor sales.

Peas are generally shipped in refrigerator cars. After the containers are loaded in the car, shippers place 4,000 to 6,000 pounds of crushed ice on top of the stacked containers, in addition to the ice placed in the bunkers. In some shipments from Texas, no ice is placed in the bunkers, but the spaces between the hampers or crates are filled with ground ice and the top is covered with a layer of ground ice.

Studies by Jones and others indicate the importance of quickly removing the peas from the field and placing them in the refrigerator car in order that the product may reach the consumer in a highly edible condition. When harvesting is done at the proper time, the most

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FIG. 109. Excellent quality peas of Laxton's Progress variety, graded and packed in bushel hampers.

important factor influencing quality is probably the temperature at which the product is held after picking.

MARKETING. Peas are marketed in a manner similar to that for other vegetable crops, the method depending upon the prevailing practice in the particular section. Where the production is controlled by an organization, it is desirable to use central packing houses not only to standardize the product but also to aid in marketing. In many instances the peas are packed on the farm by the individual growers and brought to the local market, which may be an auction or cash-track buyers' market. In some instances the peas are handled by dealers or shippers who load and sell them to cash-track buyers or ship on consignment, depending upon the market conditions.

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26

PEPPERS

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CLASSIFICATION, ORIGIN, AND HISTORY. The peppers (*Capsicum frutescens*) belong to the *Solanaceae* or nightshade family, and are therefore closely related to eggplant, potato, tomato, and tobacco. The following five botanical varieties were listed by Bailey in 1924: Var. *cerasiforme*, cherry peppers; var. *conoides*, cone peppers; var. *fasciculatum*, red cluster peppers; var. *longum*, long peppers; and var. *grossum*, bell or sweet peppers.

The native home of the peppers is thought to be tropical America, where they have always been very popular. The origin of many species of Capsicum, however, has been attributed to southern Asia, the home of the unrelated black pepper, *Piper nigrum*. After the discovery of America, peppers were rapidly disseminated over Europe.

SCOPE AND IMPORTANCE. Peppers are grown generally throughout the United States and fairly extensively in the South, ranking in some sections as one of the important commercial vegetable crops. A rather remarkable increase in the production and use of peppers in the United States has taken place within the last 25 years. This increase was due in part to the discovery that green peppers are rich in vitamin C, and ripe pimientos in vitamin A.

Approximately 17,000 acres of green peppers with a value of $2,260,000 were grown for sale in 1935. Of this total, over 80 per cent was produced in the four states of Florida, New Jersey, California, and Texas. Florida supplies most of the crop found on the northern markets during the winter months, while New Jersey markets its crop mainly in July, August, and September.

Approximately 9,000 acres of pimientos were grown annually for canning during the period 1930 to 1935 inclusive. In 1935, Georgia grew more than 11,000 acres of pimientos, worth about $450,000, while California was second with slightly over 1,000 acres. The industry in these two states was centered largely in Spalding County, Georgia, and Orange County, California.

Chili peppers are produced most extensively in Orange County, California; however, considerable quantities are grown in Arizona, New

Mexico, Louisiana, and Texas. Table 3, page 5, gives additional information on pepper acreage, yield, production, and price.

AVERAGE PRODUCTION COSTS. The cost of growing an acre of peppers in the South ranges from $40 to $75. This amount includes cost of labor, plants, fertilizer, insecticides, fungicides, marketing, rent, and interest on farm investment.

CLIMATIC REQUIREMENTS. Peppers have very much the same climatic requirements as the eggplant and tomato, although pepper plants may withstand lower temperatures. They thrive best in a relatively warm climate where the growing season is long and where there is little danger of frosts. The pepper is apparently more drought-resistant than either the tomato or eggplant; nevertheless, best yields in the South are contingent upon an ample supply of well-distributed rainfall and a mean temperature at blossom-setting time ranging from 65° to 80° F.

Irrigation is necessary in some pepper-growing sections of the West and Southwest, and it is used to some extent in the South.

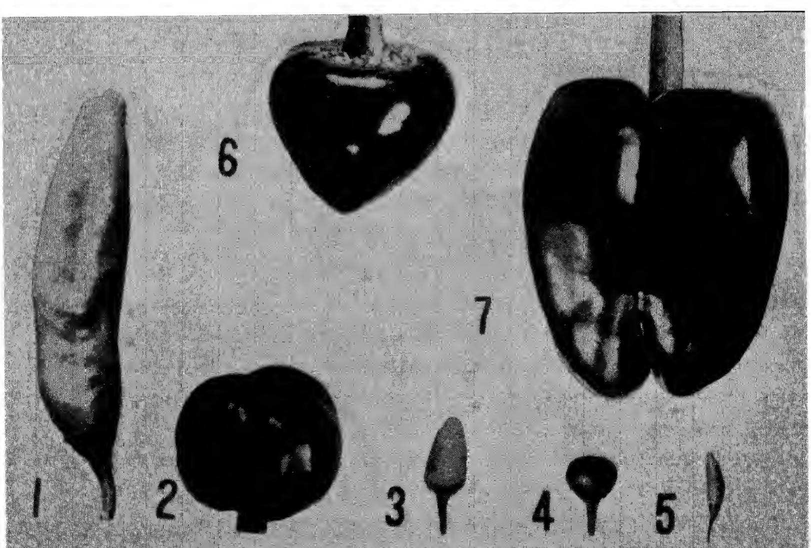

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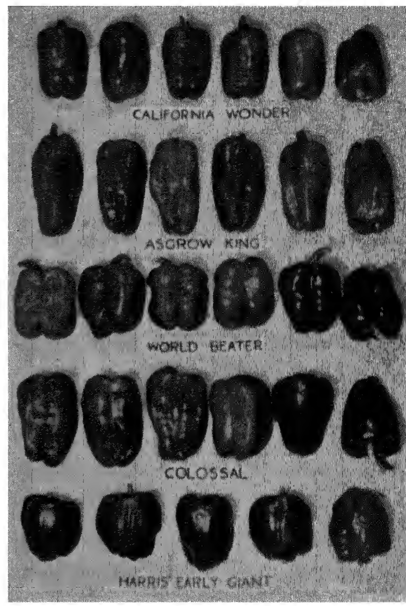
FIG. 110. Group classification of varieties of peppers. 1. Cayenne group, var. Halflong Hot; 2. Tomato group, var. Tomato; 3. Celestial group, var. Celestial; 4. Cherry group, var. Cherry; 5. Tabasco group, var. Tabasco; 6. Perfection group, var. Pimiento; 7. Bell group, var. California Wonder.

Job 1. Selecting Varieties and Seed

VARIETIES. Of the several groups of peppers grown (Fig. 110) there are two general classes: (1) Those which produce mild or sweet fruits called sweet peppers, and (2) those which bear pungent or hot fruits, better known as hot peppers. The most popular varieties of the sweet peppers are as follows:

Harris' Earliest. Fruits, pendent, slightly elongated, 3½ inches long by 3 inches in diameter, 3 lobed; flesh, thick; flavor, mild. This variety comes into bearing very early and is grown throughout the South.

World Beater. Fruits, pendent, slightly elongated, 5 inches long by 3½ inches in diameter, usually 4 lobed; flesh, medium thick; flavor, excellent. This variety is an early bearer and a heavy producer. It is grown extensively in Florida and in New Jersey (Fig. 111).



Associated Seed Growers, Inc

FIG. 111. Pepper varieties of the bell group.

California Wonder. Fruits, erect, short and blocky, 4½ inches long by 4 inches in diameter, 4 lobed; flesh, thick and firm; flavor, non-pungent. The variety is popular in all pepper-growing sections because of its superior shipping quality; however, it is only moderately productive and a little late in maturing.

Ruby King. Fruits, pendent, elongated, 5 inches long by 3 inches in diameter, 3 lobed; flesh, thick and sweet; flavor, mild. This variety has long maintained a place as a standard, moderately early pepper in the South, and has been the progenitor of several strains showing but minor variations.

Perfection Pimiento. Fruits, pendent, conical, 3½ inches long by 2½ inches in diameter; flesh, very thick, firm, and sweet; flavor, mild. This improved variety of pimiento was developed from a single plant by S. D. Riegal and Sons, Experiment, Georgia, and was placed on

the market in 1903. Today it is the principal variety grown for canning.

Well-known varieties of the pungent-fruited peppers are:

Tabasco. Fruits, erect, small, and very hot; color, red. The pods are borne mostly in pairs and average from $\frac{3}{4}$ to $1\frac{1}{2}$ inches long. The variety is named after the Tabasco River in Mexico and is used principally for the manufacture of the famous Tabasco sauce. It is grown extensively in the Evangeline section of Louisiana, and is used for Tabasco and other sauce products.

Sport. Fruits, erect, 2 to 3 inches long; dark red; very prolific. This group of peppers is intermediate between the Tabasco and Cayenne and is grown to some extent in Louisiana.

Cayenne. Fruits, pendent, curved, and ranging from 4 to 8 inches in length; flesh, thin to moderately thick; color, red. The cayenne is one of the oldest and most widely grown varieties of the hot pepper group. It is dried extensively in Louisiana, the Southwest, and in Old Mexico and is used for flavoring, condiments, and for medicinal purposes.

Cherry. Fruits, erect, cherry-shaped or globose, orange to deep red in color, solitary and three celled. The variety is used to only a minor degree as a condiment. It is an attractive ornamental plant and is widely grown under glass for the holiday trade. The plants are often confused with Jerusalem Cherry, *Solanum Pseudo-Capsicum.*

SECURING SEED. Growers should make a special effort to obtain the best seed available of varieties that are well adapted to their particular region. Proper seed production is a specialized business, and, as a rule, growers should not attempt to raise their own seed. The pimiento industry, however, has relied on the latter method almost entirely.

Job 2. Preparing the Soil

SOIL PREFERENCES. A sandy loam which holds moisture fairly well and which has a liberal supply of organic matter is the ideal soil for the growing of bell peppers. For canning peppers, a soil with some clay is preferable, as the color of the fruits seems to develop better than on lighter soils. Soils conducive to earliness are especially desirable in regions where the growing season is limited by killing frosts.

BREAKING AND CONDITIONING. Land to be planted to peppers in the spring should be broken deeply during the previous late fall or early winter. In the spring the surface should be well harrowed and the rows laid off with any convenient type of shovel plow.

FERTILIZING AND MANURING. A 4–8–6 fertilizer, applied at the rate of 600 to 1,000 pounds to the acre, is generally satisfactory for peppers. An additional side dressing of 100 to 200 pounds of nitrate of soda applied at the beginning of the blossoming period may be used profitably on green peppers for the early market but it seldom pays on late peppers. These amounts applied in two applications have been found profitable for the growing of pimientos in Georgia.

Barnyard manure, if available, should be applied to most soils of the South at the rate of 10 to 12 tons per acre and turned under a few weeks before the plants are to be set in the field. Where such applications of manure are used, commercial nitrogenous fertilizers may be dispensed with. Excessive quantities of nitrogen in the soil while increasing vegetative growth of the plants may seriously delay maturity of the fruits.

Job 3. Planting and Cultivating

GROWING THE PLANTS. Seed should be treated with red copper oxide or a similar fungicide before planting. If hotbeds are employed, the seed should be sown 4 to 6 weeks before the plants are to be set in the field. A temperature of 75° F. or higher should be maintained in the beds, if possible, until a few days after the seed germinates. The temperature should then be reduced slightly by ventilation in order to harden the plants and keep them from becoming too spindling. Small hotbeds covered with hotbed sash and heated with manure are most commonly used by growers of small or moderately large areas, whereas large commercial growers of plants resort to large steam- or hot-water-heated beds, cold frames, or planting in the open. The beds should be watered regularly and sufficiently to keep the soil moist but not wet. Excessive moisture lowers the soil temperature and encourages damping-off fungi.

SETTING THE PLANTS IN THE FIELD. It is the usual practice to set plants, 6 to 8 inches tall, in ridged rows $3\frac{1}{2}$ feet apart with the plants spaced $1\frac{1}{2}$ to $2\frac{1}{2}$ feet apart in the row. Good yields, however, are obtained in some sections of the South with closer spacings. The plants are set either by horse-drawn transplanting machines, or by hand, the former method being much faster and just as efficient. In either case, care must be taken to see that the plants are properly placed and that the soil is firmed about the roots.

CULTIVATING. As soon as the young plants have become established in the soil, they should receive shallow cultivation only often

enough to keep down the weeds and grass. Deep cultivation invariably results in root pruning as well as a drying out of the soil, both of which cause a severe check in plant growth.

Job 4. Controlling Diseases and Insects[1]

DISEASES. The pepper is subject to diseases which may become very destructive under certain conditions, especially where a large acreage is grown without proper rotation.

Damping-off, caused by *Corticium vagum*, is often very destructive to young plants in the seedbed, causing the stems to decay near the soil line. Usually it can be kept under control by planting the seeds in rows 4 to 6 inches apart and stirring the surface soil soon after each rain in order to keep it loose and dry. In rainy weather, other means of control are sometimes necessary. A band of air-slaked lime between the rows or Semesan solution (1 to 400) applied at the rate of one quart to each square foot of space will usually hold the disease in check.

Bacterial spot, associated with *Bacterium vesicatorium*, causes small, dark-brown, wartlike spots to occur on leaves and fruits. During damp weather the disease spreads rapidly and may cause almost complete defoliation of the plants. The spots in the fruits allow the entrance of molds and other decay organisms. The same disease is common on the tomato. Seed treatment, seedbed sanitation, and crop rotation are the recommended control methods.

Southern blight, associated with *Sclerotium rolfsii*, is often one of the most destructive pepper diseases in the South. The plants are attacked near the soil line and during dry periods the roots are destroyed. The plants turn yellow and wilt gradually. A carefully planned rotation is the only means of control which can be recommended. Peppers should never be planted after soybeans or cowpeas, but cotton, corn, and small grains are almost immune and are good crops to precede peppers.

Blossom-end rot (physiological) causes spots to appear near the tips of the fruits during dry periods before the plants have established a large root system. The early crop is most seriously affected. The spots usually become infected with Alternaria and other fungi which may decay the entire fruit. The plants should be set deeply in well-prepared soil. Disturbing the roots after fruiting begins should be avoided.

Anthracnose, caused by *Gloeosporium piperatum*, frequently causes serious spotting of both green and ripe peppers. The fungus lives on

[1] Pepper Diseases prepared by B. B. Higgins, Botanist, Georgia Experiment Station. Pepper Insects prepared by T. L. Bissell, Entomologist, Georgia Experiment Station.

and within the seed coat, and that within the seed coat cannot be killed by seed treatment. Seeds should be saved from disease-free fruits, and treated to destroy any spores that may adhere to them.

Ripe rot, associated with *Vermicularia capsici*, is the most serious disease of the pimiento pepper, destroying the fruits after they have ripened. Like the anthracnose fungus, it penetrates the seed coat and is not controlled by seed treatment. It also lives from season to season in the field. Careful seed selection from disease-free fields and crop rotation are necessary for control.

Nematodes (Root knot). (See page 218.)

TREATING SEED. Pepper seeds should be given a disinfectant treatment immediately after removal from the fruits. At this time, the seeds are turgid and not so easily injured by chemicals, the surface is moist and easily wet, and the fungi and bacteria are more easily killed. They should be soaked for 90 minutes in a Semesan solution (1 to 400), drained, and spread to dry without washing.

SPRAYING. The value of the pimiento pepper crop, in particular, seldom justifies the cost of spraying after the plants are set in the field. However, the plants can be sprayed in the seedbed with very little cost, and this is a valuable precaution to prevent rapid spread of diseases that may appear on the young plants. Two applications of a 4–6–50 Bordeaux (in terms of hydrated lime) will usually be sufficient for this purpose.

INSECTS. There are two important insect pests of peppers in the United States, both of which attack the fruit.

The pepper weevil (*Anthonomus eugenii*) is closely related to the cotton boll weevil but is much smaller. Grubs feed in blossoms and in the core of young pods, causing the fruits to drop prematurely. This pest is established in California, New Mexico, and Texas; and in 1935, there was an outbreak in Florida. It breeds during the winter in the western states on black nightshade, *Solanum nigrum*, and it is essential that this weed be eradicated around pepper fields. The remains of the pepper crop should also be disposed of after harvest.

The pepper maggot (*Spilographa electa*) is the larva of a species of fruit fly. Eggs are laid through the wall of the pod and the maggots feed on the core, causing it to rot. The maggot is very injurious in New Jersey, and it is known to occur in northern Florida and also may appear in other pepper-growing sections. Horse nettle is a native host plant, and the eggplant also is sometimes infested. Picking of peppers while

they are green prevents great injury by the pepper maggot, though the cores may already be infested. When fruits are kept covered with a dust of talc, oviposition is prevented.

Job 5. Harvesting, Processing, and Marketing

HARVESTING. The time to harvest bell peppers should be determined largely by the size of the fruit and its stage of maturity. For market, they are picked as soon as they reach approximately full size and become firm, but before they begin to turn red or yellow, as the respective colors may be when ripe. Green peppers are picked in baskets and hauled to central packing sheds for grading. Yields ranging from 2 to 4 tons per acre may be expected on the most fertile soils, though greater yields have been reported.

Practically all of the pimientos grown are canned in the red or ripe stage. They are harvested either in cotton-picking sacks or in baskets, and are hauled in bags to the cannery, where they are run through grading machines and then processed. Yields of 2 to 4 tons of pimientos per acre are considered average.

Pepper yields are at times unusually low because of the dropping of the young buds, blossoms, and immature fruits. Growers have attributed this almost complete shedding to various conditions, but results of controlled experiments at Ithaca, New York, justify the conclusion that hot dry weather is the condition that causes most of the difficulty. The soil fertility also is important.

The pepper has been classed as a warm-season crop, yet it will stand a great deal of rather cool weather provided the change is not too sudden. In fact, maximum yields may be expected when the crop has a medium cool growing season and an ample supply of soil moisture, especially during the critical period of early bud and blossom formation. These conditions can perhaps best be duplicated in the field from year to year by setting the plants out as early as possible after the last killing frost and irrigating or making every effort to conserve the moisture content of the soil.

GRADING AND PACKING. Bell peppers after reaching the packing shed are graded either by hand or by machinery. In some sections of the South, the crop is packed for shipment in specially constructed 1½-bushel crates, which are easier to handle and ship than the standard 1-bushel hamper, which is still used to some extent.

Peppers are sold commercially in four grades: U. S. Fancy, U. S. No. 1,

U. S. No. 2, and Unclassified. The current grade specifications may be secured from the United States Department of Agriculture.

MARKETING. The green bell pepper is a perishable crop, and should be sold as soon after it is picked as possible. The crop is moved short distances from the packing plant by truck, but to large terminal markets in refrigerated freight cars. Buyers for large produce companies or dealers make it their business to visit the intensive vegetable-growing sections of the South and West and purchase most of the peppers in season, f.o.b., the growers' shipping points. Some of the growers, however, sell their crop through certain local vegetable associations and a few sell on consignment, the latter method usually being the last resort.

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27

ROOT CROPS

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Root crops include the beet, carrot, turnip, rutabaga, and radish. These crops are grown for an enlarged fleshy structure called the root. This enlarged root consists of both root and stem tissue. From the lower part arises the absorbing roots and from the upper part arises the stems and leaves. All root crops thrive best in relatively cool weather and have similar cultural requirements; and all are biennials except the radish, which is either annual or biennial. In the South, these crops are grown in the fall, winter, and early spring.

Beet

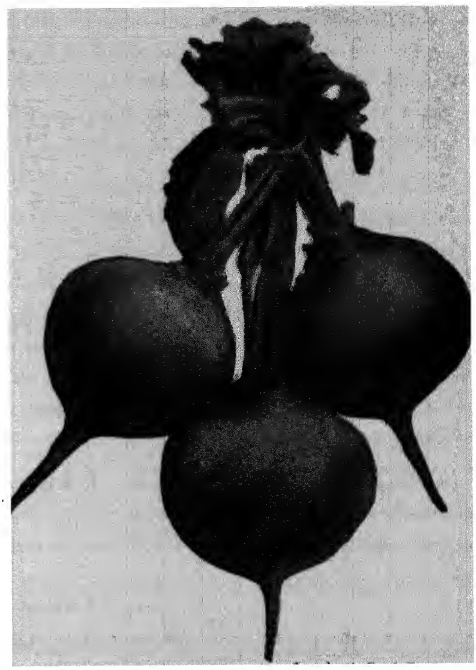
CLASSIFICATION AND HISTORY. The beet (*Beta vulgaris*) is a native of Europe, North Africa, and West Asia. De Candolle states that though the ancients knew about the beet, they did not cultivate it until the third century A.D. The Germans and French became interested in beets about the year 1800. Since that time, many improved types have been developed. At the present time, the beet is grown in practically all home gardens but its commercial value is relatively low.

PLANT CHARACTERISTICS. The edible portion of the root consists of alternating circular bands of conducting and storage tissues. The alternating bands consist of relatively broad dark bands of storage cells and relatively narrow light bands of conducting cells. The contrast in color between these alternating bands is known as zoning, which varies greatly between varieties and within a variety.

The beet has a relatively large absorbing system. Studies at the New York (Cornell) Agricultural Experiment Station have shown that the roots extend downward 2½ to 3 feet and that numerous branches arise in close proximity to the enlarged roots.

The stem is short and platelike; the leaves are simple and arranged in a closed spiral on a short stem called the crown. They vary from dark red to light green. Stomata occur on both the upper and lower surface. The so-called seed is really a fruit which contains from two to five or six seeds.

SELECTING VARIETIES. In general, beet varieties are classified according to the shape and the time of maturity of the root. There are (1) flat or globular, early-maturing varieties, (2) globular, second, early-maturing varieties, and (3) long, late-maturing varieties. Representative varieties of the flat or globular, early-maturing sorts are Crosby's Egyptian (60 days), Early Wonder (58 days), and Eclipse. Representative varieties of the globular, second-early sorts are Detroit Dark Red (68 days), and Ohio Canner (66 days). A representative variety of long, late-maturing sorts is Long Smooth Blood (80 days). The Crosby's Egyptian and Eclipse are early market garden varieties, the Detroit Dark Red is a second-early market garden beet and is used for canning and for general purposes in the home garden (Fig. 112).



Landreth Seed Company

FIG. 112. The Detroit Dark Red, a second-early general-purpose variety.

PREPARING THE SEEDBED. Beets thrive best in well-drained, slightly-acid sandy loams, loams, silt loams, and high-lime mucks. In the South, well-drained sandy loams and loams are used.

Soil preparation should be thorough. Deep plowing, immediately followed by disking, pulverizes the surface, promotes the formation of a fine seedbed, and conserves moisture.

Experimental information on the fertilization of the beet, particularly in the southern states, is lacking; therefore, the practices of successful growers should be followed. As with other crops, the kind and amount of commercial fertilizer required varies with the soil type, soil fertility, previous fertilization, and the rotation. On sandy loams in South Carolina, a 5–7–5 mixture applied at rates varying from 1,000 to 1,500 pounds per acre is recommended. On similar soils in Mississippi,

Alabama, and Louisiana a 4–8–4 mixture applied at 1,000 to 1,500 pounds per acre is used.

PLANTING AND THINNING. The seed balls are planted by hand or by the seed drill at rates varying from 8 to 12 pounds per acre. Thinning is necessary as each seed ball may produce from one to five or six plants. In market gardens and in home gardens thinning is frequently delayed until the plants are sufficiently large for use. In fields of beets grown for the cannery, thinning is done when the plants are seedlings. In general, plants are thinned 3 to 4 inches apart.

CULTIVATING. Investigations have shown that weeds markedly decrease the yields of beets and that continuous cultivation of a sandy loam in the absence of weeds slightly increased the yields. However, in some years continuous cultivation decreased the yields.

In general, the cultivation program will depend on the type of soil, the season at which the crop is grown, the character of the rainfall, and the prevalence of weeds. On light soils it is less necessary than on heavy soils. Seasons of heavy rainfall require more cultivation than seasons of light rainfall.

CONTROLLING PESTS. Principal pests are leaf spot, a fungus disease, and the leaf miner, a white maggot. Both pests are controlled largely by practicing sanitation and rotation.

Carrot[1]

CLASSIFICATION AND HISTORY. The carrot (*Daucus carota* var. *sativa*) is a native of Europe and adjoining portions of Asia. The Vilmorins, notable seedsmen of France, are responsible for the early development of the carrot. In the short space of 3 years, they developed roots similar in appearance to the well-known varieties of the present day from the thin wirelike roots of the wild carrot. In the sixteenth century, roots which varied in size, color, and shape were known in Europe. In the New World, the carrot soon became popular among the Indians. In fact, the flat-head Indians of Oregon were so fond of them that they could not forbear stealing them from the fields. Carrots are an excellent source of vitamin A and a good source of vitamins B, C, and G(B_2).

PLANT CHARACTERISTICS. A cross section of the root shows two distinct regions, an outer core and an inner core. The outer core

[1] The contributor is indebted to H. H. Zimmerley, J. C. Miller, and J. M. Jenkins, Jr., for information on the growing of carrots.

consists of (1) a thin periderm, a layer of cork cells, and (2) a relatively wide band of secondary phloem, the region where sugars are mainly stored. The inner core consists of (1) secondary xylem and (2) pith. High-quality carrots are those which have a relatively large outer core. Investigators have shown that the outer core contains more vitamin A than the inner core.

Carrots develop a deep extensive absorbing system. During the seedling stage, the absorbing roots develop rather slowly, but as the edible portion enlarges, it gives rise to a large number of fine absorbing roots. Investigations at the New York (Cornell) Agricultural Experiment Station have shown that carrots growing in gravelly sandy loam fill the soil with roots to depths of 25 to 30 inches.

The stem consists of a small platelike crown which develops from the plumule. During the second year the platelike stem elongates and forms branches 2 to 4 feet high which bear the flowers and seed. The leaves arise in the form of a rosette and are long-petioled and decompound. The seed is a very small, dry, indehiscent, one-seeded fruit. It germinates very slowly and requires a fine, friable seedbed and a uniform supply of moisture.

Data presented in Table 46 show the acreage, yield, and prices in the United States for 1926, 1929, 1932, and 1935.

TABLE 46. ACREAGE, YIELD, AND PRICE PER BUSHEL OF CARROTS GROWN IN THE UNITED STATES

YEAR	ACREAGE	YIELD PER ACRE (BUSHELS)	PRICE PER BUSHEL (DOLLARS)
1926	19,000	291	0.64
1929	30,570	333	0.58
1932	29,850	362	0.60
1935	36,810	363	0.56

Crops and Markets, December, 1929, and December, 1935

TEMPERATURE REQUIREMENTS. Recent investigations at the New York (Cornell) Agricultural Experiment Station have shown that temperature has a marked effect on the growth and shape of the root of the Chantenay variety. Total growth was greater and type of growth more normal at 60° to 70° F. than at 70° to 80° F., or 50° to 60° F., or 40° to 50° F. As the temperature was increased, roots of the Chantenay became shortened like those of Oxheart. When the temperature was decreased, the roots became long and pointed, more like those of Long Orange.

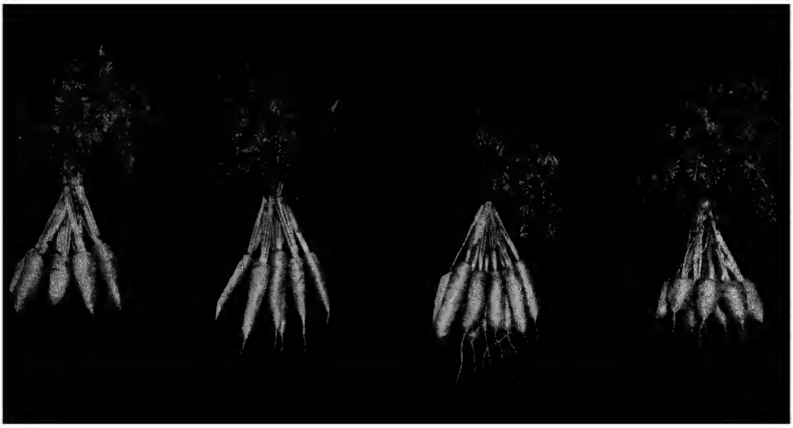


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FIG. 113. Common varieties of carrots. Left to right. Chantenay, Danvers, Coreless (Nantes), Oxheart

SELECTING VARIETIES. Carrots are generally classified according to shape and length of the root. There are (1) varieties which are blunt and (2) those which are pointed. Within the former class there are varieties which are short (length not exceeding twice the diameter) and those which are moderately short (length exceeding two but not four times the diameter). Within the latter class there are varieties which are moderately short (length not exceeding four times the diameter) and those which are long (length exceeding four times the diameter).

French Forcing is a representative variety of the blunt-short type, Chantenay is representative of the blunt half-long type, Danvers Half Long is of the pointed half-long type, and Long Orange is a representative variety of the pointed-long type. Principal commercial varieties are Chantenay, Danvers Half Long, Nantes, and Imperator. Of these, Danvers Half Long, Chantenay, and Nantes are the most important (Fig. 113).

PREPARING THE SOIL. For best development the carrot requires deep, loose, sandy loams or loams with a slightly acid reaction. If carrots are grown on comparatively heavy soil, they are likely to produce abundant leaf growth and forked roots. In South Carolina, they are grown on Norfolk sandy loam; in Virginia, on Norfolk sandy loam and Myock sandy loam; in Louisiana, on Bluff silt loams and Sharkey soils.

Since carrot seed is small, and since the seedling grows slowly, the seedbed should be in fine physical condition. In the South, the crop is grown either on raised beds or on the level. Raised beds 3 to 5 feet wide are used mostly in the Norfolk, Virginia, section while single rows 1 foot apart are used in the Charleston, South Carolina, central Mississippi, and Louisiana sections. The beds, 3 to 4 feet apart, are made sufficiently high for drainage and sufficiently early to permit settling by rain. Ridging is followed by harrowing and smoothing.

PLANTING. The seed is planted about $\frac{1}{8}$ inch deep, just enough to cover the seed with a drill. Rate of seeding per acre varies with the method of planting and distance between rows. Rates used in the following sections are: Norfolk, Virginia, 3 to 5 pounds; Charleston, South Carolina, 5 to 10 pounds; and Louisiana, 2 to 3 pounds.

Time of planting varies with the section. In Louisiana, the early or mid-winter crop is planted from September 20 to October 10 and the late or spring crop is planted from January 20 to February 15. According to recommendations of the Louisiana Experiment Station, carrots for commercial purposes should not be planted between October 10 and January 20 because (1) severe freezes and rains are frequently disastrous, and (2) the mature roots are frequently light yellow and thus fail to pass inspection at the shipping point. In central Mississippi, plantings are made between February 1 and March 1 and in the Charleston district, between October 15 and November 30.

FERTILIZING. The kind and amount of fertilizer to apply varies with the locality and time of year the crop is grown. In Virginia, a 6–6–5 mixture is applied before the seed is sown, and a 9–5–4 mixture is used as a side dressing. In South Carolina, a 5–7–5 mixture is applied at the rate of 1,000 pounds per acre. In Louisiana, 400 to 600 pounds of a 4–8–4 or 4–12–4 mixture per acre are recommended.

Temperature and soil type have a marked effect on the color of carrots. Investigations at the New York (Cornell) Agricultural Experiment Station have shown that the best color was obtained between 60° and 70° F. At temperatures below this range the lower portion of the root presented a bleached appearance. Investigations at Louisiana State University have shown that, on a percentage basis, carrots grown on Bluff silt soil were more poorly colored than those grown on Ridgeford silt clay, Sharkey clay, and fine sandy loam.

CULTIVATING. Since the seedlings grow slowly, weed control, particularly during the early portion of the growing season, is necessary.

Turnip [1]

CLASSIFICATION AND HISTORY. The turnip (*Brassica rapa*) is a native of Siberia. It was grown in olden times and introduced into England about 1550.

PLANT CHARACTERISTICS. The turnip develops an extensive and finely branched root system. Studies at the Nebraska Agricultural Experiment Station have shown that plants 3 weeks old have deep roots 2 feet long. Plants 41 days old have roots which extend to the 3-foot level. The leaves which arise in the form of a rosette are simple, grass-green, and hairy. Seed is small, reddish black, and germinates quickly. The turnip is primarily a cool-season crop, hence it is grown in the fall, winter, and early spring in the South.

SELECTING VARIETIES. Two groups exist, the white-fleshed group and the yellow-fleshed group, the white-fleshed group being the more important. Within this group there are (1) those varieties grown primarily for the top and (2) those grown primarily for the root. Principal varieties grown for the top are Japanese Shogoin, Seven Top, and Southern Prize, while the principal varieties grown for the root are Purple Top White Globe, White Flat Dutch, and White Milan.

PREPARING THE SOIL. Turnips thrive well on most well-drained, moderately to slightly acid sandy loams and loams. In south Mississippi, where Orangeburg, Ruston, Cahaba, and Norfolk sandy loams are used, certain soil preparation practices have been developed, including flat breaking, disking, and furrowing. Plowing and disking are done about 2 weeks before the seed is planted. About 500 pounds of a 4–8–4 mixture is applied in the furrow, and approximately 100 pounds of nitrate of soda is used as a side dressing, about 3 weeks after planting.

PLANTING. Seed is planted either by hand or by machine, at the rate of 2 or 3 pounds per acre when the rows are spaced 3 feet apart.

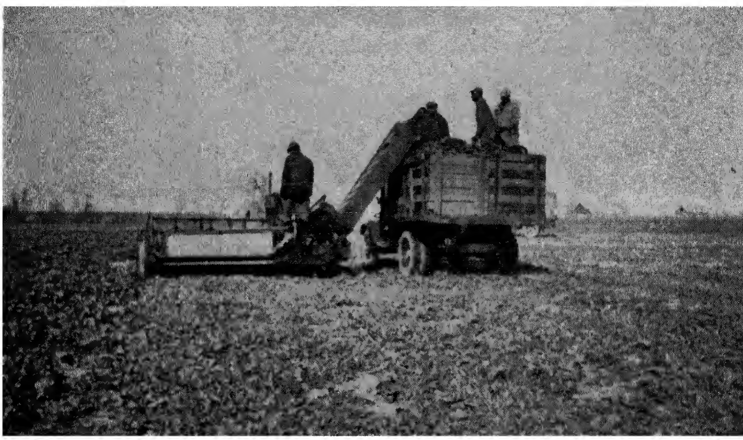
CULTIVATING. The cultivation program is similar to that of other root crops. The first or second cultivation may be relatively deep to permit lateral root penetration, but succeeding cultivations should be shallow. Various types of cultivators are used, including sweeps on single-stock plows, double shovels, and Planet Junior cultivators.

CONTROLLING PESTS. Leaf spot is the principal disease of the turnip. The causal organism is a fungus which produces small, circular,

[1] The contributor is indebted to W. S. Anderson, horticulturist, Laurel Starch Plant, Mississippi, for information on the growing of turnips in south Mississippi.

grayish spots, $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter on both sides of the leaves. In some cases, the leaves turn yellow prematurely and die. The disease is most prevalent during wet weather. Crop rotation is a recommended measure of control.

The principal turnip insect is the aphid, and maintaining vigorous growth is a recommended measure of control. In south Mississippi, the vegetable weevil is prevalent to some extent. Crop rotation seems to control this pest satisfactorily.



G. L. White, Mississippi County, Arkansas

FIG. 114. Cutting and loading turnip greens with an improvised binder and elevator.

HARVESTING, PACKING, AND MARKETING. Preparing turnip roots for market consists of (1) pulling, (2) grading, (3) bunching, and (4) washing. Pulling is done by hand, and yellow, diseased, or injured leaves are removed. In general, four to six plants are tied together and washed to remove adhering soil. Packing consists of placing the bunches in bushel baskets, bushel crates, or Louisiana crates. Shipment is usually under refrigeration.

When the tops of turnips are harvested as greens, they are either picked or cut by hand or cut by improvised machines as shown in Figure 114. Turnip greens may be graded and packed or sold in bulk.

Rutabaga

The rutabaga (*Brassica Napobrassica*), sometimes called Swede turnip, closely resembles the turnip. Distinguishing characteristics between the two crops follow:

Parts Compared	Turnip Characteristics	Rutabaga Characteristics
Leaves	green and hairy	grayish green and non-hairy
Crown	indistinct	distinct
Root	small	large

The cultural requirements of the rutabaga are similar to those of the turnip. The principal variety grown is American Yellow Purple Top.

Radish[1]

HISTORY AND CLASSIFICATION. The writings of ancient naturalists indicate that the radish (*Raphanus sativus*) has been cultivated for a long time. Pliny records that it was extensively cultivated in Egypt at the time of the Pharaohs. The Greeks were especially fond of radishes and in their sacrificial offerings to Apollo, they were always served on dishes of gold. The radish was introduced into England and France about the beginning of the sixteenth century. In 1806, eleven sorts were known in America.

PLANT CHARACTERISTICS. The edible portion consists of both root and stem tissue, which varies greatly in color, size, shape, and texture of the flesh. Color varies from white to black. Size and shape are the most distinguishing characteristics.

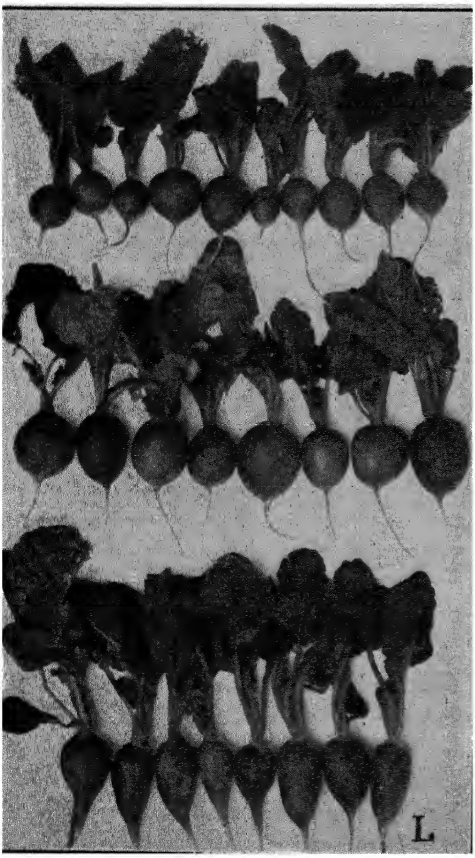
According to investigations at the Nebraska Agricultural Experiment Station, the absorbing system is not very extensive. Though certain absorbing roots had a lateral spread of 12 to 16 inches, most of the roots were 2 to 8 inches long. Radishes can be cultivated 2 inches deep with little damage to the root system.

The stem is a short crown, and when the plant produces seed, the stem elongates and bears perfect, insect-pollinated flowers and podded fruits. Some varieties bear flowers and seed the first year, while others bear seed the second year; hence the radish is either an annual or a biennial. With the annual varieties, flowering is apparently controlled by the length of the day. The Scarlet Globe, an important commercial variety, was grown under a 7-hour day at Washington, D. C., in the spring of 1920; other lots were grown under a 12-hour day. The plants subjected to the 7-hour day produced a large, overgrown root, while those subjected to a

[1] The contributor is indebted to Chesley Hines, county agent, Gulfport, Mississippi, for information on the growing of radishes in south Mississippi.

12-hour day produced flowers and seeds. The leaves which arise in a rosette are simple and lobed, and vary in size according to the variety.

TEMPERATURE REQUIREMENTS. The radish is a hardy, cool-season crop which withstands sub-freezing temperatures. Certain varieties, particularly the spring varieties, become pithy in hot weather.



Landreth Seed Company

FIG. 115. Scarlet Globe radishes planted at shallow, intermediate, and deep depths. Those in the middle were planted at the correct depth.

SELECTING VARIETIES. Varieties are classified according to the length of time for the roots to attain maturity. There are (1) the spring varieties, (2) the summer varieties, and (3) the winter varieties. The spring varieties grow quickly, mature in a relatively short time (25 to 30 days), and the root remains in an edible condition for a short time only. The summer varieties grow less quickly, mature in a relatively longer time (45 to 50 days), and the root remains in an edible condition longer. The winter varieties grow slowly, attain a larger size, and can be stored readily.

Representative spring varieties are Early Scarlet Globe, Scarlet Turnip, Crimson Giant, and White Icicle. Typical summer varieties are Strasburg and White Vienna, and representative winter varieties are China Rose and Long Black Spanish. The early-maturing sorts are the most important commercially. Important varieties are Early Scarlet Globe, Vick's Scarlet Globe, Cincinnati Market, and White Lady Finger.

SELECTING AND PREPARING SOILS. In general, radishes produce satisfactory crops on well-drained, moderately to slightly-acid sandy loams, loams, and clay loams, the type of loam depending on the type of radish grown. Sandy loams are preferred for the growing of crops for market in the spring, while well-drained silt and clay loams are preferred for the growing of the summer and winter sorts.

In the vicinity of Gulfport, Mississippi, radishes are raised for long-distance shipment. The land is plowed 8 inches deep and beds are made 6 inches high and 6 feet wide. This comparatively high bed facilitates drainage. Fertilization consists of broadcasting a 4–8–4 mixture at the rate of 1,000 pounds per acre just before the beds are made.

PLANTING. Seed is broadcast by hand at the rate of 8 to 10 pounds per acre and harrowed into the soil. Very little weeding is necessary. In this district, the principal pests are nematodes and aphids. Nematodes are controlled by growing nematode-resistant crops in rotation and aphids are controlled by the use of nicotine sulfate.

Investigations at the Mississippi Agricultural Experiment Station have shown that depth of planting of the Scarlet Globe markedly influences the shape of the root. Figure 115 shows the shape of roots planted at shallow, intermediate, and deep depths. Data in Table 47 show that seed planted $1\frac{1}{2}$ inches deep produced roots possessing a greater length and a lesser width than did seed planted $\frac{1}{2}$ inch deep. Since slightly elongated roots are less preferable on the market than round, globular roots, depth of planting is particularly important.

TABLE 47. INFLUENCE OF PLANTING DEPTH ON THE SHAPE OF THE SCARLET GLOBE RADISH, 1933[1]

PLANTING DEPTH (INCHES)	NUMBER ROOTS	AVERAGE DIAMETER (CENTIMETERS)		ARITHMETIC MEAN
		Length	Width	
1.5	211	2.558	1.269	2.084
0.5	262	2.242	1.403	1.627
Difference (1.5 minus 0.5)		0.316	− 0.134	0.457[2]

[1] (After Edmond) (Strain 542, U. S. Seed Co.).
[2] The difference is considered significant.

HARVESTING AND MARKETING. Harvesting operations consist of pulling, washing, grading, bunching, and packing. All small, diseased, and cracked roots are discarded. The number of plants per

bunch depends on the variety. Long rooted varieties are bunched in fours and fives, while round and globular rooted varieties are bunched in fifteens and twenties. Bushel boxes and bushel baskets are the principal containers. For long-distance shipment, cracked ice is placed in the middle and top of the containers and the radishes are shipped under refrigeration. Winter radishes are stored in soil banks in much the same way as are turnips, carrots, or sweet potatoes.

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28

SPINACH

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CLASSIFICATION, ORIGIN, AND HISTORY. Spinach (*Spinacia oleracea*) belongs to the *Chenopodiaceae* family, which includes the beet and chard. The genus *Spinacia* is small. Two types of spinach are commonly recognized, namely, the prickly-seeded, which is the species type, and the smooth-seeded, classified botanically by some as *S. oleracea* var. *inermis*.

Spinach was first introduced into Europe in the thirteenth or fourteenth century, coming from Asia, where it originated, by the way of Africa. The date of its introduction to the United States is unknown, but records indicate it was commonly grown in the early nineteenth century.

SCOPE AND IMPORTANCE. Although cultivated for many centuries, spinach only in comparatively recent years became commercially important. This is largely because of the wide publicity given to the value of vitamins and various minerals in the diet, and the high vitamin and mineral content of spinach. Commercial spinach production in the United States centers chiefly in Texas, Virginia, and California. Practically the entire crop from the first two states is shipped to market, while most of the California crop is canned. In recent years, Texas has dominated the spinach market. Spinach culture in Virginia centers around Norfolk; and in Texas, the industry is located chiefly in the irrigated Winter Garden region, with Crystal City being the leading shipping point. Table 48 shows the acreage, yield, production, value, and shipping season of important southern and other leading states.

AVERAGE PRODUCTION COSTS. Except in those sections where heavy applications of fertilizer are made, the cost of growing spinach is comparatively low. The cost of packages, harvesting, and selling frequently exceeds the growing cost four to ten times. In Texas, total costs on irrigated farms may range from $50 to $115 an acre, while on dry land farms, these expenses may be $5 to $10 less. In Virginia, the use of fertilizer increases the expense, but the growers are somewhat compensated by not having to irrigate.

Table 48. Estimated Commercial Acreage, Production, Value, Carlot Shipment, and Shipping Season of (Market) Spinach in Important Southern and Other Leading States, 1929–1935 Average[1]

States	Acreage	Yield per Acre	Production[2]	Price per Bushel	Farm Value	Carlot Shipments[3]	Principal Shipping Season
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
Texas	32,551	189	6,162	.43	2,442	5,949	Nov.–Apr.
Virginia	6,036	287	1,731	.49	847	1,686	Nov.–May
Louisiana	1,484	94	139	.41	57	8	Jan.–Apr.
Arkansas	856	146	125	.49	61	110	Apr., May
South Carolina . .	250	212	53	.72	38	49	Jan.–Apr.
Other States							
New Jersey . . .	3,045	349	1,063	.54	574	15	Apr., May
Pennsylvania . .	2,040	316	644	.55	353	1	Apr., May
Missouri	1,846	245	454	.41	185	83	Apr., May
Indiana	1,429	267	381	.40	151	216	Jan.–Mar.
California	1,180	719	848	.40	339	147	Jan.–Mar.
Total (average) for the 15 leading states	52,973	227	12,047	.44	5,243	8,499	Nov.–May

[1] Does not include spinach for canning. California and Maryland lead in the production of canning spinach with an average acreage of 10,014 and 1,771, respectively, for the 1929–1935 period.

[2] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[3] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

CLIMATIC REQUIREMENTS. Spinach is essentially a hardy, cool-season crop, excellently adapted to the mild winters of the South. When fairly well hardened, it has survived temperatures of 20° F. or lower without suffering injury. High temperatures and especially long days cause spinach to bolt to seed, thus destroying its market value. In general, it is a short-season crop, maturing in from 6 to 10 weeks, depending on climatic conditions.

Job 1. Selecting Varieties and Seed

Market demand, earliness, disease resistance, tendency to bolt to seed, and time of the year to be planted, are factors which need to be considered in selecting a variety.

VARIETIES. Geise and Farley in 1929, and Drewes in 1932 classified and described spinach varieties rather completely. In addition to

classifying them as prickly-seeded or smooth-seeded, varieties may also be grouped as savoy-leaf (wrinkled) or flat-leaf. The climatic conditions of the extreme South modify the appearance and performance of some varieties, but do not change the main grouping of these northern workers.

Bloomsdale Savoy is the most widely grown variety in the South. Virginia Savoy, developed by the Virginia Truck Experiment Station, is resistant to yellows. Long-standing Bloomsdale and Nobel Giant Leaf also are grown to a considerable extent. The leading characteristics of these and other varieties are given in a parallel description in Table 49.

TABLE 49. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF SPINACH

Variety	Chief Use	Season	Plant		Tendency to Bolt	Leaf	
			Size, breadth in inches	Habit		Savoying	Color (green)
Bloomsdale Long-standing	home, market, shipping	medium to late	medium, 12–18	semierect	slight	much	medium-dark
Bloomsdale Savoy	home market, shipping	early	medium, 13–18	fairly erect	rather great	medium	medium-dark
King of Denmark	home, canning	mid-season	large, 18–24	low spreading	slight to medium	slight	dark
Nobel Giant Leaf	home, market, canning	second early	large, 19–24	spreading	slight	none to slight	medium-dark
Old Dominion	home, market, canning	early	medium, 13–18	fairly erect	rather great	slight to medium	medium-dark
Princess Juliana	home, market, shipping	very late	small, 6–12	spreading	very slight to medium	medium	very dark
Virginia Savoy (Blight-resistant savoy)	home, market, shipping	early	medium, 13–18	fairly erect	great	slight to medium	medium-dark
Viroflay	home, market, canning	early mid-season	large, 19–24	spreading	medium	none	medium-dark

SECURING SEED. Most of the seed used by American growers comes from Europe (chiefly Holland). Relatively small amounts are also grown on Long Island, New York, in California, and in the Puget Sound district. Lower production costs favor the European grower.

It pays to buy seed from a reliable seedsman who makes it a practice to supply high-quality seed.

Job 2. Preparing the Seedbed

SOIL PREFERENCES. Spinach grows well on a wide range of soils, but it yields best on a heavy loam. In southwest Texas, much of the spinach is grown on well-drained alluvial soils, silt and clay loams, but sandy loams also are used fairly widely. In Virginia, there are large acreages of spinach on sandy and gravelly loams. A soil should have good drainage and if possible be well supplied with organic matter.

BREAKING AND CONDITIONING. Land to be planted to spinach should be put in a condition of good tilth, which requires that it be plowed at least 8 inches deep, and harrowed thoroughly. In irrigated sections, it may be necessary to level the seedbed so that the water will flow evenly.

FERTILIZING. Commercial fertilizers are used at fairly heavy rates in the spinach-producing areas of Virginia. Zimmerley recommends applying 800 pounds of an 8–7–5 fertilizer and working it well into the soil before planting. Should it seem necessary, a top dressing of 400 to 500 pounds of 9–8–3 or 10–5–3 may also be applied after the crop is thinned, with still another application in the case of late crops. Zimmerley also has worked out in considerable detail a series of 9–8–3 mixtures composed of different fertilizer materials. The residues of the various combinations affect the acidity or alkalinity of the soil differently, giving the grower a wider opportunity to meet the different situations as conditions warrant.[1] So far, commercial fertilizers have been used only to a small extent for spinach in Texas. With plenty of land available, it has been the practice to clear and plant on new land.

LIMING. Experimental results obtained by Zimmerley and others indicate that spinach is very sensitive to acid conditions, and will not thrive on soils more acid than *p*H 5.5. Plants grown on soils with reactions below *p*H 5 usually show severe injury. Normally, for spinach to make optimum growth, a soil should range between *p*H 6.0 and *p*H 7.0. Zimmerley found also that unfavorable acid conditions could be corrected successfully by liming the soil. An application of 1 ton per acre of hydrated lime on two sandy loams, one with *p*H 4.6, the other with *p*H 4.7 increased the yield of spinach 102 and 71 barrels per acre, respectively. Heavier applications increased yields still further, in those

[1] Virginia Truck Exp. Sta. Bull. 63, 1928.

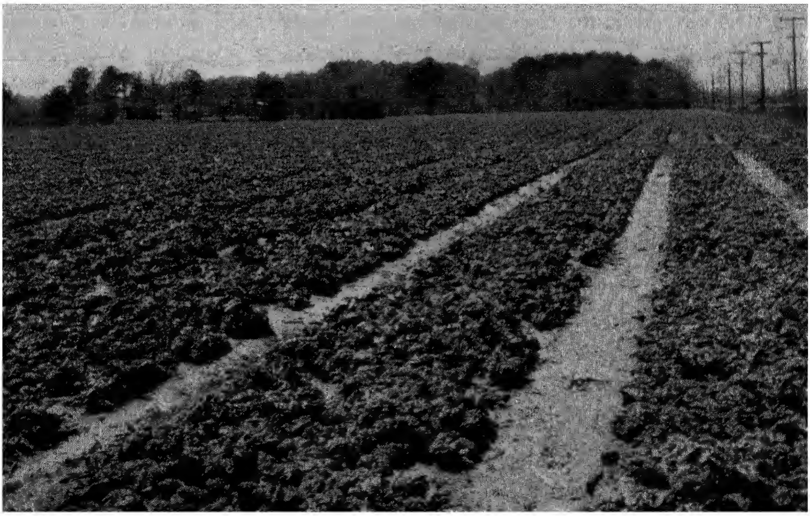
instances where the soil was strongly acid. In spite of the response to liming, the practice can be overdone.

The spinach soils in Texas have a reaction of about pH 7.0 (neutral) with a tendency towards higher pH, rather than lower. Liming is unnecessary under average conditions in the Southwest.

MANURING. The relative scarcity and the high cost of barnyard manure make its use prohibitive to the average spinach grower, even though its addition is beneficial. Green manuring is becoming more common among Texas spinach growers. However, preliminary experiments at the Texas Experiment Station indicate that such manures plowed under in the season ahead of spinach will not increase yields materially, if at all. A legume green-manure crop incorporated in the soil fully a year ahead of the spinach crop seems most feasible.

Job 3. Planting and Cultivating

PLANTING. In the extreme South, spinach is planted at any time from September until early February. In more northerly sections late winter plantings are made for spring harvests, or the crop may be wintered over after being planted in the fall. Spinach planted in late



Va. Truck, Exp. Sta.

FIG. 116. A common method of planting spinach in Virginia; raised beds each containing 6 rows. This is the Old Dominion variety.

summer is harvested in the fall. Rate of seeding varies greatly, depending somewhat on the spacing but to a greater extent on the section of the country and local experience. In the northerly sections of the South, seed is drilled at rates ranging from 15 to 30 pounds per acre, 20 pounds being an average rate. Recent discoveries in treating seed may lead to a reduction of these rates. In Texas, when the seed is broadcast, 8 to 10 pounds per acre is more normal, and even 8 pounds may give too thick a stand. When drilled in rows, 4 to 6 pounds will suffice.

Until very recently it has been the common practice of growers in the Winter Garden region of Texas to broadcast the spinach seed with a drill, using a board suspended below the openings to scatter the seed. Row planting is becoming more common at present. In Virginia, as well as in most other sections, row planting long has been an established practice. Rows in Texas are usually either 14 or 16 inches apart, and may be flat or raised on low ridges according to the method of irrigation. In Virginia, spinach is planted on broad, slightly raised beds in which there are usually 5 to 6 rows 8 to 10 inches apart (Fig. 116). Spinach is usually planted about ½ inch deep, depending on method of planting and soil conditions. The furrow between the beds creates ideal drainage conditions.

THINNING. As soon as the young crop has become well established, growers in the more northerly and eastern sections of the South thin the plants to stand 4 to 6 inches apart. Thinning is rarely practiced in Texas.

CULTIVATING. Wherever spinach is planted in rows, shallow cultivation is usually practiced to reduce weed growth. Frequent cultivation in the absence of weeds is unnecessary. Either wheel hoes or horse-drawn cultivators can be used. Until very recently, it was impossible to cultivate many Texas spinach fields because of the broadcast method of planting. The increase of weeds under such a cultural system is causing many growers to plant in rows in order to cultivate.

IRRIGATING. In the irrigated sections of the Southwest, irrigation is one of the major concerns of the spinach grower. The first irrigation immediately follows planting. This irrigation will frequently bring up the crop, but sometimes a second application is necessary within 3 or 4 days if the soil dries too quickly. Between emergence and harvesting, one to three irrigations are usually required, depending on soil and climatic conditions. Experiments at the Texas Experiment Station show that over-irrigation of spinach will definitely reduce yields.

FIG. 117. Irrigating a field of spinach by the border method of surface irrigation in Texas To the right is the main supply ditch The spinach is the Bloomsdale variety.

Fields are irrigated either by flooding (border method), as shown in Figure 117, or by the furrow method. In the former method the rows are flat, while in the latter they are on low, raised ridges.

Job 4. Controlling Diseases and Insects

DISEASES. Spinach is subject to a number of diseases, including damping-off, mosaic, downy mildew, and fusarium wilt. It is seldom that all of these are injurious in any given region at the same time.

Damping-off as well as closely related rots of germinating seeds and unemerged seedlings are responsible, to a large extent, for the poor stands obtained under certain conditions, and for the necessity in the past of such high rates of seeding. Work of Horsfall has drawn attention to the great value of red copper oxide and zinc oxide in seed treatments. As a result of Horsfall's studies in New York and those of others at the Virginia Truck Experiment Station, it is possible to prevent poor stands of spinach by dusting the seed with red copper oxide, Vasco 4, or zinc oxide. The practice has become widespread in Virginia.

Mosaic, commonly known as blight, or yellows, sometimes causes serious losses, especially in Virginia. In the early stages of the disease, the young center leaves turn yellow and cease to grow. Later, all growth stops and the larger leaves become mottled, and even turn brown and die. It has been shown that insects, especially plant lice, carry the disease from plant to plant. The most practical method of control is to grow Virginia Savoy and Old Dominion, two blight-resistant varieties developed by the Virginia Truck Experiment Station.

Downy-mildew, caused by *Peronospora effusa* and known in Virginia and Texas as blue mold, may cause serious losses in foggy or rainy weather. The disease first appears on the under side of the leaves where irregular patches of grayish mycelia will be found. Later the upper surface of the leaves turns yellowish. Under favorable conditions, the disease spreads rapidly, and whole fields of spinach are quickly ruined. No effective means of control have been found.

Fusarium wilt, caused by *Fusarium solani*, may be troublesome in Texas either in early fall or in spring plantings. Young plants, if attacked, remain stunted, and old plants wilt, and rarely recover. Air temperatures above 72° F. or soil temperatures at the depth of 2 inches above 70° F. favor spread of the disease. Growing spinach during cool weather is the only known means of practical control.

Curly-top. During the 1935–1936 season, a severe outbreak of a disease believed to be identical with curly-top of beets occurred in Texas spinach fields. It is possible that this disease may be a factor in future production. The only known carrier of this disease is the beet leafhopper, an insect which is not always present in Texas. Control measures have not been established.

INSECTS. There are only two serious insect pests of spinach, (1) aphids, and (2) the seed corn maggot or spinach bud worm.

Aphids (*Myzus persicae*) or plant lice sometimes cause serious damage to spinach by sucking the juice from the foliage, and by transmitting the mosaic disease from infected plants to healthy ones. Because the spinach plants grow close to the ground in a more or less compact rosette, control by dusting or spraying is not easy. Some control has been obtained in Virginia by using a hydrated lime dust containing 2 to 3 per cent nicotine. Severe infestations of the spinach aphid are rather rare in Texas.

Spinach bud worms (*Hylemyia*) ruin many plants in Texas in some seasons. They render the plant unmarketable by feeding on the

center bud and small immature leaves. They appear usually during protracted periods of cloudy weather. With the coming of sunny days, infestations decrease and may entirely disappear within a few weeks. Infestations occur more often where organic matter recently has been plowed under; hence, to avoid this practice may give partial control.

Job 5. Harvesting, Processing, and Marketing

HARVESTING. The time of harvesting depends on the market as well as the size of the plant. When the price is high, growers may harvest medium-sized plants having only five to seven fully matured leaves, but, if the price is low, the plants will probably be allowed to continue growing. After a seed stalk begins to form, a spinach plant is no longer marketable; hence, high value is attached to long-standing varieties.

The harvesting period in the extreme South extends from early November to April of the following year; in more northerly sections, it occurs only during the fall, spring, and early summer. More than one cutting in the same field can be made, if only the large plants are taken.

Spinach plants are harvested by cutting the tap root at the soil surface, with various kinds of knives or hoes. Usually each plant is cut separately, although there are special tools which are pushed along the row, cutting many plants in one operation. Unsightly and dead leaves should be removed. In Virginia and Texas, such trimming is done in the field as each plant is cut, but, in other sections, plants may sometimes be trimmed in packing sheds. When grown for manufacture, the trimming is done at the canning plant. Spinach sometimes has to be washed, but such a practice should be avoided if possible before long-distance shipping, as it hastens decay.

GRADING. It is a common practice to grade the spinach in accordance with the standards set up by the federal-state inspection service. A certificate signed by an official inspector assures both the seller and the buyer that the product at the time of shipment was a certain grade. The grades applying to spinach change slightly from time to time, and it is well to obtain periodically the latest rulings direct from the United States Department of Agriculture. Because of the nature of a spinach plant, all grading has to be done by hand, and hence it is often done as the plants are harvested.

PACKING. In the extreme South, spinach is packed almost entirely in bushel baskets, but in the more northerly sections, hampers and crates

Tex Exp Sta

FIG. 118. Icing spinach at a loading platform A shovelful of cracked ice (approximately 10 lbs) is placed in each basket

also are used. For long-distance shipping, a shovelful of ice (approximately 10 pounds) is placed in the upper portion of each basket just before it is put in the car (Fig. 118), and the car also is iced.

MARKETING. In the large commercial spinach sections of Virginia and Texas, most of the spinach is sold for cash as it is loaded in the cars. The buyers, shippers, and commission houses buying the spinach keep in close touch with the market of the entire United States and route their shipments on the basis of demand. Most markets prefer the savoyed varieties, but a few, notably Chicago, handle the flat-leaved types. Spinach for canning is usually bought by local factories.

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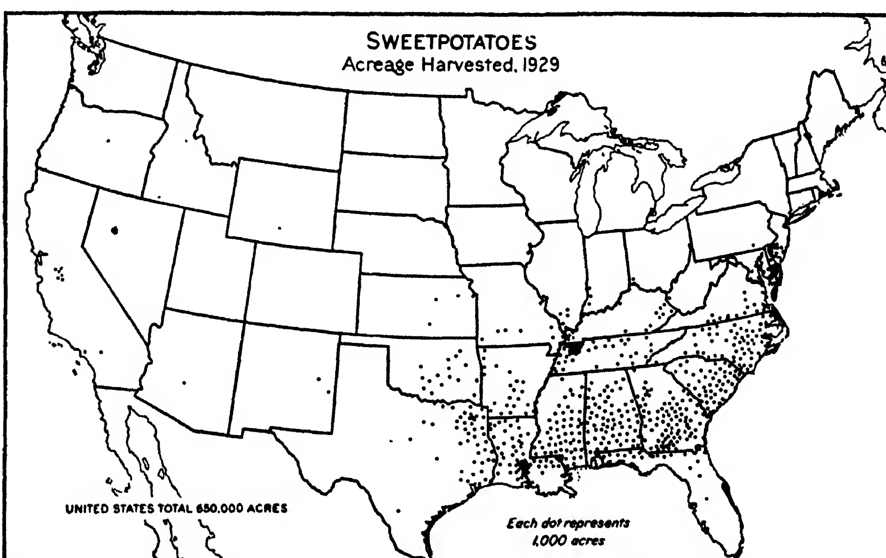
29

SWEET POTATOES

Brooks D. Drain, Tennessee Experiment Station, Contributor

CLASSIFICATION, ORIGIN, AND HISTORY. The sweet potato (*Ipomoea Batatas*) is a native of Central and South America, belonging to the morning glory family, *Convolvulaceae*. Early explorers carried it to Spain and other subtropical and tropical countries, and the earliest writers mentioned different varieties and colors. The sweet potato has been grown in Virginia for nearly 300 years. The name "batatas" was used by the Indians in referring to this vegetable. The term "yam," as commonly used in the South, usually refers to the more moist-fleshed varieties, although there is a different group of plants known as yams.

SCOPE AND IMPORTANCE. The sweet potato is grown extensively in the South, and is the great carbohydrate food crop of the southern states, corresponding to the Irish potato in more northern sections. Unlike the Irish potato, it was not extensively shipped until



U. S. Dept. of Agr.

Fig. 119. Harvested acreage and distribution of sweet potatoes.

the recent development of proper storage. Carlot shipments do not give a true picture of sweet potato production, as a large part of the crop is consumed locally. Acreage figures indicate the more important production centers, although yields vary greatly on different soils, and production fluctuates from year to year in the different states. Important data showing the acreage, distribution, farm value, and carlot shipment of sweet potatoes are given in Figure 119 and Table 50.

TABLE 50. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF SWEET POTATOES IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1927–1933 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION	PRICE PER BUSHEL	FARM VALUE	CARLOT SHIPMENTS [1]	PRINCIPAL SHIPPING SEASON [2]
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
Georgia	90,571	77	6,997	.83	5,835	419	July, Aug.
Alabama	75,286	83	6,232	.85	5,312	413	July, Aug.
North Carolina	74,857	95	7,124	.79	5,613	992	Aug.–Mar.
Louisiana	71,857	74	5,284	.86	4,525	1,197	Aug.–Oct.
Texas	64,714	77	4,977	.86	4,290	722	Nov., Dec.
Mississippi	58,857	98	5,761	.76	4,388	152	Aug.
Tennessee	58,571	90	5,275	.73	3,855	3,282	Oct.–June
South Carolina	51,714	88	4,565	.73	3,341	221	Nov.–Jan.
Virginia	36,857	118	4,358	.76	3,296	5,755	Aug.–Nov.
Arkansas	28,000	86	2,408	.82	1,975	259	Nov.–Mar.
Florida	20,857	79	1,646	1.01	1,657	127	July
Kentucky	17,857	80	1,437	1.00	1,440	273	Oct.–Dec.
Oklahoma	17,429	88	1,528	.80	1,224	150	Nov.–Mar.
Other States							
New Jersey	12,000	138	1,651	1.06	1,753	1,252	Sept., Oct.
California	11,143	96	1,066	1.03	1,094	790	Sept.–Nov.
Total (average) for the 22 leading states	732,143	89	65,071	.86	55,724	19,550	Jan.–Dec.

[1] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments, which exceed carlot and boat shipments.

[2] Applies to crop movement without regard to harvest season.

AVERAGE PRODUCTION COSTS. The sweet potato is a comparatively inexpensive crop to grow. Costs vary from $30 to $60 per acre, depending upon land values, cost of securing slips, soil fertility, availability of cheap labor, and other production factors which differ considerably within the South.

Woodard, under Georgia conditions, has shown the relation of spacing and fertilizer to acre costs and to value of No. 1 roots produced (Table 51).

TABLE 51. COST ESTIMATES AND RETURNS IN RELATION TO SWEET POTATO SPACING

Distance in Drill, in Inches[1]	Number Plants per Acre	Pounds of 4-8-4 Fertilizer per Acre	Cost per Acre		Value No. 1's per Acre at $0.75 per Bu.	Acre Returns on No. 1's above Cost of Plants and Fertilizer[2]
			Plants at $1 per 1,000	Fertilizer at $25 per ton		
4	37,428	3,200	$37.42	$40.00	$115.01	$37.59
8	18,714	1,600	18.71	20.00	93.32	54.61
12	12,478	1,066	12.47	13.32	70.01	44.22
16	9,357	800	9.35	10.00	48.02	28.67
20	7,485	640	7.48	8.00	47.41	31.93
24	6,238	533	6.23	6.66	40.92	28.03
28	5,347	457	5.34	5.71	31.06	20.01

[1] All rows spaced 3½ feet apart.
[2] It is assumed that No. 2's and culls will cover planting, cultivating, and harvesting costs.

CLIMATIC REQUIREMENTS. The sweet potato thrives in the warmer portion of the United States from New Jersey to Texas. It can be grown under irrigation, although it is considered a drought-resistant plant. Irrigation water is best applied before the vines cover the ground, as late applications may result in excessive vine growth. The leaves, vines, and the entire plant are easily injured by frost.

Finch and Baker considered 175 frost-free days as best, although the more northern producing centers have as little as four months. Warm nights and plenty of sunshine increase growth. Harter and Whitney found that growth increased up to 95° F.

Job 1. Selecting Varieties and Seed

VARIETIES. Beattie and Zimmerley list nine varieties as the more important from the market standpoint, although many others are grown to some extent. Strains of Yellow Jersey and Big Stem Jersey are grown in Virginia and New Jersey as northern markets are accustomed to dry-fleshed potatoes. Porto Rico (Fig. 120) and Nancy Hall (Fig. 121) have moist flesh and are preferred in most southern sections. The Tennessee Experiment Station found Southern Queen to do especially well on soils of low fertility. Its production is limited, although it yields

well and keeps satisfactorily in storage. Triumph is not especially popular on southern markets, because its flesh is only medium moist.

A brief comparative description of the more important commercial varieties is given in Table 52.

TABLE 52. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF SWEET POTATOES

Variety	Season	Vine Diameter and Individual Length in Feet	Leaf Size and Shape	Roots (Potatoes)			
				Size and shape	Color (1) outside, (2) flesh	Eating quality	Texture
Big Stem Jersey	medium to late	large, 6–12	medium, shouldered	medium, long, fusiform	(1) russet yellow, (2) yellow	sweet	dry, mealy, firm
Dooley	late	medium, 10–15	large, shouldered or entire	large, short, fusiform	(1) salmon, (2) dark orange	sweet	squashlike, soft
Gold Skin	mid-season	slender, 6–10	medium, shouldered, or entire	medium, fusiform	(1) dark yellow, (2) salmon	very sweet	dry, firm
Porto Rico	medium early	medium, 5–10	large, shouldered	medium, fusiform to globular	(1) rose, (2) salmon	very sweet	moist, soft
Pumpkin Yam	late	medium, large, 6–12	large, shouldered	medium, fusiform	(1) yellow, (2) orange	very sweet	moist, soft
Nancy Hall	early	medium, 4–8	medium, entire	medium, fusiform	(1) yellow, (2) dark yellow	very sweet	moist, soft
Red Jersey	medium to late	slender, 6–12	medium, shouldered, or entire	small, spindle	(1) red, (2) yellow	fairly sweet	dry, mealy, firm
Southern Queen	mid-season	large, 6–12	shouldered or entire	medium, large, globular, ovoid	(1) cream, (2) light yellow	sweet	moist, soft
Triumph	early	large, bushy, 2–4	large, shouldered	medium, large, long, cylindrical	(1) light yellow, (2) yellow	fairly sweet	medium, dry, firm
Yellow Jersey	mid-season	small, 5–10	medium, shouldered	small, fusiform or ovoid	(1) russet yellow, (2) yellow	fairly sweet	dry, mealy, quite firm

SECURING SEED. If high yields of uniform, marketable potatoes are desired, only well-selected seed should be used, as unselected seed is

often mixed in type if not in variety. Unless the local supply is known to be free from diseases and insects, certified seed should be purchased. Sporting or mutation is not very common, but often causes considerable variation. Hill selections can be used in maintaining type and to secure seed free from disease.

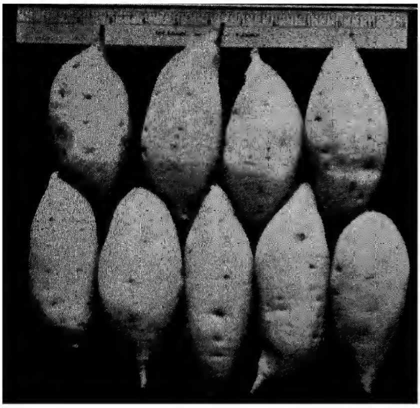


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FIG. 120. Typical Porto Rico sweet potatoes. This variety and the Nancy Hall, shown in Figure 121, are leading moist-fleshed southern varities.

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FIG. 121. Nancy Hall sweet potatoes.

Job 2. Preparing the Soil

SOIL PREFERENCES. It is generally agreed that a sandy-loam soil with a clay subsoil is best for sweet potatoes. Roots from such a soil tend to be smooth and not too large. Cut-over pine land is easily tilled and often produces excellent crops if well drained and sufficiently supplied with organic matter. While clay loams are less easily tilled, and tend to produce relatively more large roots, they often give good yields and require smaller annual applications of mineral fertilizer.

PREPARING THE SOIL. A fair crop of sweet potatoes can be grown on carelessly prepared soil, but thorough preparation will usually give larger yields and reduce labor later. The soil should be plowed and worked down about the same as for corn and similar crops. Then the land is generally allowed to lie several days before being put into condition for planting. A large part of this crop is planted on ridges made up several days before planting. The tops of the ridges are rolled or dragged off at planting time. A low flat ridge is more

desirable than a narrow high one, as the latter drys out badly. Level culture has some advantages on sandy, well-drained soils.

Job 3. Fertilizing and Manuring

FERTILIZING. The New Jersey Station found that potash had a striking influence on shape of the Jersey type of sweet potato when grown on sandy soil. Similar experiments at the Tennessee Station on clay loam soils failed to show an appreciable effect on shape except where the soil was of very low fertility. In general, late planting and an excess of nitrogen tend to produce long slender roots that mature late. Early planting and an abundance of potash tend to produce early-maturing chunky potatoes. Cooper and Watts recommend 400 to 500 pounds of a 4–12–4 fertilizer per acre on the heavier soils of northwestern Arkansas and as much as 500 pounds of 8–8–8 for the lighter soils in the southern part of that state. Woodard concluded that applications ranging from 400 to 800 pounds per acre of a 4–8–4 fertilizer should prove profitable for sweet potatoes on the principal soil types of South Georgia. A fertilizer containing 4 per cent nitrogen, 6 per cent acid phosphate, and 6 per cent potash is recommended for sweet potatoes in Florida. While no definite amount is recommended, more than 600 pounds per acre is seldom profitable on light, poor soils. Northern growers of the Jersey type tend to increase the percentage of potash on the lighter soils.

Heavy applications of mineral fertilizers in the drill often cause injury to newly transplanted plants. Several plans are followed to avoid this injury, such as (1) broadcasting before making up the ridges, (2) mixing with the soil in the drill, and (3) applying as a side dressing after the plants have become established. The first may result in leaching on light soils. Side dressing costs somewhat more but should enable the young plants to make good use of the fertilizer applied.

MANURING. Stable manure is usually scarce and expensive to purchase. Mineral fertilizers are widely used in growing sweet potatoes, and stable manure is applied to other crops. It is a common practice for those who use manure to apply it in a furrow under the ridge and at the rate of 2 to 5 tons per acre. Fresh stable manure on fertile loams often results in oversize and irregularly shaped roots. Sandy soils often need a green manure crop, such as crimson clover, soybeans, or cowpeas, to increase their water-holding capacity. These legumes should be disked and plowed under at least a month before the plants are set.

The tops and vines of a peanut crop, after hogging-off, often serve as a green-manure crop.

Job 4. Growing and Caring for Slips

SIZE OF SEED. It is a standard practice to use small or medium-sized roots for seed purposes. Roots from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in diameter will produce more plants per bushel of seed and per square yard of seedbed than will larger potatoes. Such seed should be free from disease, clean, vigorous, and true to the type desired for the variety. Many experiments indicate that there is no significant difference between plants from large and small seed if other factors are equal. This is as one would expect in vegetative propagation.

TREATING SEED. Even seed which is apparently healthy should be treated as a precaution against scurf, stem rot, black rot, and foot rot before it is bedded. United States Department of Agriculture Farmers' Bulletin 1059 presents the following treatment for stem rot: "In the spring just before they are bedded, the seed potatoes should be disinfected by treating them for 8 to 10 minutes in a solution made by dissolving 1 ounce of corrosive sublimate in 8 gallons of water. Only wooden vessels should be used for disinfection. Corrosive sublimate is a strong poison and should be kept out of the reach of animals. This treatment will not kill the stem-rot fungus within the potato, but it will destroy any spores that may be on the surface. After treating about 10 bushels in 24 gallons of solution, $\frac{1}{2}$ ounce of corrosive sublimate dissolved in hot water should be added and the solution made up to the original volume by the addition of water. Repeat the process after the treatment of each 10 bushels until 30 bushels are treated, then throw away the solution and start with a fresh one. If for any reason corrosive sublimate cannot be used, the potatoes may be immersed for 5 minutes in a solution of formaldehyde made by adding 1 pint of commercial formalin to 30 gallons of water." In addition, all parts of the seedbed which were previously used for bedding sweet potatoes should be disinfected with the same solution. Crates and storage rooms are occasionally treated in the same way.

BEDDING. Clean, fresh sand on which sweet potatoes have not been grown for a number of years is preferred as a bedding medium. This is often hauled from woodlands to avoid all chance of contamination. Plant beds should be located on a sheltered slope where sweet potatoes have not been grown recently. About 25 square feet of bed are required

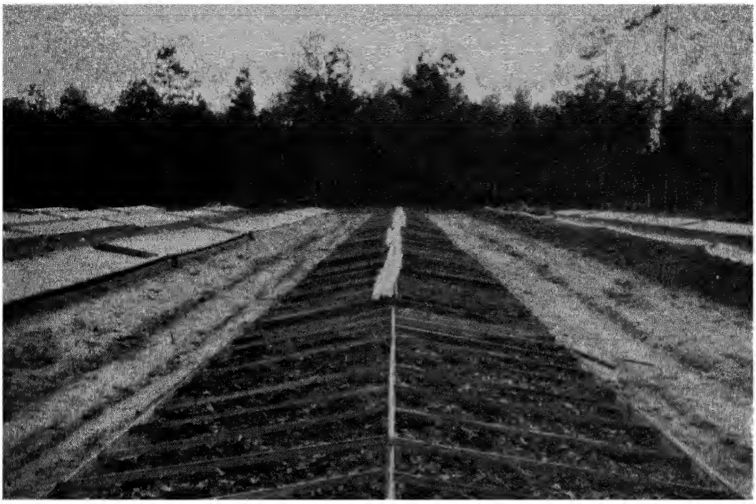

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FIG. 122. Cold frames are used to a considerable extent in some sections of the South in growing slips.

for one bushel of so-called strings or 15 square feet for one bushel of No. 1's. About 6 to 7 bushels of seed are allowed for each acre where one pulling is made and only the slips are planted. In long-season sections, growers bed enough roots for one-fifth to one-eighth of their planting and then take vine cuttings to plant the remainder of their crop.

In the warmer sections, unheated open beds or cold frames commonly are used (Fig. 122). The former are usually 5 to 6 feet wide and as long as necessary. A pit may be dug about 6 inches deep and the bedding medium filled in or the potatoes bedded in the soil without excavating. In either case, the roots are covered about 1 inch deep and additional sand is applied when the sprouts appear. A deep layer of soil delays sprouting of newly bedded potatoes. There should be 4 to 6 inches of soil over the mother potatoes at pulling time to insure long, stocky, well-rooted slips. Canvas and sash covers produce somewhat earlier plants.

In the more northern sections, plants are grown in heated beds to secure as long a growing season as possible. Such beds are started about 6 weeks before the plants are to be set in the field. The beds may be heated by manure, hot air, steam, hot water, or electricity, as described in Chapter 7.

CARING FOR THE BEDS. High temperatures increase the rate of growth, but produce soft, weak plants. An air temperature of 70° to 80° F. is considered best for most of the growing period. Covered beds will need ventilation on bright days to control the temperature. Beds with dry heat require more water than those heated by manure. Unheated beds often need covering on very cold nights, as the plants are easily injured by frost. It is well to harden off the plants by increasing the ventilation just before planting time.

Job 5. Pulling and Setting Slips

PULLING SLIPS. In drawing the slips, the seed potato is held down with one hand while the plants are removed with the thumb and finger of the other. Only plants that have formed good roots are taken, and the others are left to grow (Fig. 123). Plants to be set with a transplanting machine must be arranged in the best possible way, which includes trimming the tops and placing all of the roots in one direction in such manner as to avoid sticking. Some growers puddle the roots in mud, others cover them with wet burlap, and some even omit the water in their planting machine if planting is done on cloudy days following a rain.

SETTING SLIPS. Sweet potato slips are set in the northern section as soon as danger of frost is over. Where only a few hundred plants are

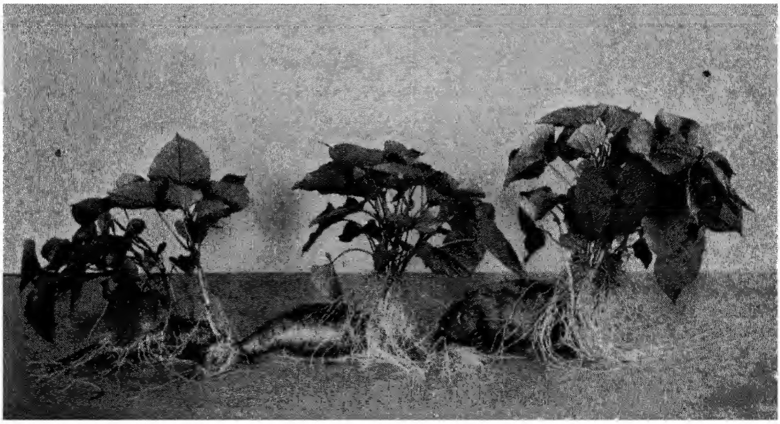

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FIG. 123. Large, well-developed, hardy slips give best results. Sweet potato slips normally grow on the end attached to the vine, as shown.

to be set, hand planting with a dibble or a trowel is the common method. It is usually convenient to water such plants or they may be puddled in a paste of clay and water before setting. For larger areas, the shovel and tongs method is fairly rapid and less tiresome than hand planting with a dibble. The shovel, a sharpened piece of lath, is used to open the soil and is managed in the right hand. Tongs made of wood are used to pick up the slip by the roots and to thrust it into the ground. The soil may be firmed about the roots with the foot or by a second thrust of the shovel. Some of the larger commercial areas use planting machines which can plant 3 to 4 acres a day under favorable conditions, with the assistance of a team, a driver, and two helpers.

Miller and Kimbrough found that early-planted Porto Rico potatoes produced more chunky roots than late-planted ones. However, the soil should be warm and all danger of late frosts over before the plants are set in the field. Vine cuttings are inexpensive and help to control disease but should be managed so as not to delay planting too long.

PLANTING RATES. The distance between rows and spacing within the row depend on such factors as time of setting, variety, and soil type and fertility. Large-growing varieties such as Porto Rico and Southern Queen need more space than do those with shorter vines. Close spacing, 9 to 12 inches in the row, is desirable on rich fertile soils, as it reduces the number of jumbos and may increase the yield as shown in Table 53.

TABLE 53. SPACING OF NANCY HALL SWEET POTATO PLANTS[1]

Spacing of Plants, Inches	Yields per Acre in Bushels						
	1924	1926	1928	1929	1930	1931	Average
6	336.0	263.0	398.4	135.0	392.0	236.0	293.4
12	288.0	222.0	388.8	109.0	336.0	240.0	263.8
18	215.0	183.0	331.2	109.0	309.0	213.5	226.8
24	278.0	183.0	331.2	109.0	292.0	209.0	233.7

West Tenn. Exp. Sta.

[1] Rows 3 feet apart; soil, a fertile loam.

SETTING VINES. A large part of the sweet potatoes in the lower South is grown from vine cuttings, the vines being secured from an early planting of slips. This method of propagation is relatively inexpensive and involves less danger from diseases. Such cuttings are usually about 15 inches long and should include two joints. The Georgia Experiment

Station found little difference between cuttings taken from various parts of the same vine. Such pieces of vines may be planted by pushing the middle portion into the soil with a notched stick or by inserting the butt end 6 to 8 inches into the soil. Vine cuttings are fairly resistant to adverse conditions.

Job 6. Cultivating and Weeding

CULTIVATING. Sweet potatoes are given the usual row cultivations practiced with other crops, mainly for the purpose of controlling weeds. Two hoeings and several cultivations are usually made before the vines seriously interfere with the cultivators. The sweet potato vine takes root at various places if left undisturbed. Moving the vines to permit late cultivations may slightly increase yields, but it is not likely to be profitable. Vine pruning to stimulate development of roots has retarded root development in several experiments and is of questionable value.

WEEDING. Hand work is expensive and some growers use level culture and cultivate in both directions. This reduces the amount of hoeing necessary. Most soils will require two hoeings and perhaps some pulling of large weeds after the field has been laid by.

Job 7. Controlling Diseases and Insects

DISEASES. A number of serious diseases attack the sweet potato. The more important ones, including control measures, are discussed briefly.

Black rot, caused by the fungus *Ceratostomella fimbriata,* is generally considered to be the most destructive of the field diseases of the sweet potato. It attacks all parts of the plant below the ground. This fungus lives from one year to another on the dead vines or other decayed vegetable matter in the soil and infects sweet potato by contact. Slips from diseased seed are usually infected.

Precautions necessary to avoid this disease include selecting disease-free seed, disinfecting as described under seed treatment, and avoiding all contaminated material in manure or about the plant beds. Crop rotation tends to prevent an accumulation of diseased material in the soil. Spring selection as well as fall selection helps to avoid using any diseased roots.

Stem rot, caused by *Fusarium batatis* and *F. hyperoxysporium,* is about second in destructiveness in most sections. These two fungi,

like the preceding one, can live for several years on decaying vegetation in the soil. Entrance usually occurs through the roots, and the foliage of infected plants turns yellow. The vascular system is usually invaded by the fungus, and dark-colored lesions are found on the stem. The discoloration disclosed by splitting the stems is used to identify infected seed. Spores of the stem-rot fungi are developed on dead vines and are readily carried by wind and other agencies.

Varieties show a marked difference in susceptibility to this disease. Nancy Hall and Porto Rico are moderately susceptible, while Triumph is fairly resistant. The same sanitary measures described for black rot apply to this disease. Infected soil should not be planted to sweet potatoes for at least 5 years.

Scurf, caused by *Monilochaetes infuscans*, is one of the secondary sweet potato diseases, although it is widely disseminated. The fungus lives in the soil, can be carried on slips, and causes no apparent injury above ground. Diseased areas on the potatoes are brown and are likely to continue to develop in storage. Discolored roots lose water and are likely to shrivel even in fairly humid storage houses. The use of disease-free seed and treatment with bichloride of mercury are important preventive measures. Infected soil should not be planted to sweet potatoes for at least 3 years.

Foot rot is caused by a soil fungus, *Plenodomus destruens*, which causes a firm brown rot on late-infected potatoes. Early-infected plants are attacked near the surface of the ground and are usually girdled. Control measures are the same as for black rot.

Root rot, caused by *Ozonium omnivorum*, is often called Texas root rot and is induced by the same organism that causes root rot on cotton and alfalfa. Its distribution is limited to southwestern United States. No satisfactory control is known; however, hard freezing is likely to kill the organism. Corn and cereals may be grown in an effort to starve out the fungus.

Root knot, caused by the common garden nematode, may result in a superficial decay in sweet potatoes, which are likely to spread this pest. Porto Rico and Jersey varieties are claimed to be fairly resistant. Good crops of sweet potatoes have been grown on badly infested soil. No method of seed treatment is known which will kill the worms in the fleshy roots.

Soft rot, including ring rot, is usually caused by the common bread-mold fungus, *Rhizopus nigricans*. Ring rot develops in storage from a side infection and the diseased tissue forms a ring about the potato.

Soft rot under favorable conditions may start in the field. The middle cell wall is dissolved during the spread of this rot, which at first renders the potato soft and mushy. Loss of water later produces a dry, mummy-like condition often called a dry rot. Entrance starts at wounds, although a rotting potato often infects surrounding ones. A relatively low humidity during the curing process decreases infections. As this fungus lives on a wide range of decaying vegetable matter, it cannot be excluded from storage houses. Proper curing and handling are the best preventive measures.

Dry rot, caused by the fungus *Diaporthe batatatis*, like soft rot is widely distributed. It probably starts in the field and develops slowly from the stem end. Small domelike fruiting structures can often be seen with the naked eye. The tissue under the skin is coal-black in appearance.

Storage diseases include soft rot, dry rot, Java black rot, charcoal rot, and field diseases that continue to develop in storage. Their control starts with the development of a clean healthy crop in the field. Entrance of such diseases is favored by injury and careless handling in harvesting and storing. Proper curing and favorable storage conditions prevent such diseases from getting a start. Storage houses should be thoroughly cleaned and disinfected with formaldehyde or corrosive sublimate, as explained on page 354, before storing the crop.

INSECTS. The sweet potato is usually free from very serious insect attacks.

The sweet potato weevil (*Cylas formicarius*) is of Asiatic origin and is the most serious insect pest of this crop. Other host plants include members of the morning glory family. The adult of this insect is a slender snout beetle about $\frac{1}{4}$ inch long. The larvae tunnel through the vines to the roots and often riddle the potatoes. The weevil overwinters in potatoes in storage and in roots left in the ground. Serious damage occurs from this pest from Texas to Florida.

Suggested control measures include (1) cleaning up sweet potato fields after harvest, (2) disposing of the crop as soon as possible after digging, (3) selecting only clean seed at bedding time, and (4) growing plants as far away from infested fields as possible.

Other insects which occasionally attack this crop include cutworm, sweet potato flea beetle, striped beetle, sweet potato white fly, and sweet potato plum moth. The injury resulting from these insects is usually slight.

Job 8. Harvesting, Processing, and Marketing

HARVESTING. Mature sweet potatoes are characterized by high starch content, the cut surfaces drying on exposure to air. The crop may be dug at any time when the roots reach marketable size. Table 54 shows the influence of time of digging on total yield and grade of potatoes. While these figures are for 1 year only, they indicate that very early digging must be accompanied by increased price to offset the reduction in grade and yield.

TABLE 54. DATES OF HARVESTING SWEET POTATOES

Date Dug	Grades	Variety Yields				
		Triumph	Nancy Hall	Yellow Jersey[1]	Southern Queen	Porto Rico
August 15	Marketable	41.2	89.5	55.6	41.1	48.4
	Strings	26.6	72.6	91.9	44.8	46.0
	Total	67.8	162.1	147.5	85.9	94.4
September 1	Marketable	111.3	179.1	96.8	85.3	111.3
	Strings	38.7	116.1	87.1	55.6	50.8
	Total	150.0	295.2	183.9	140.9	162.1
September 15 . . .	Marketable	248.3	280.7	137.9	179.1	227.9
	Strings	99.2	41.1	94.4	32.7	81.1
	Total	347.5	321.8	232.3	211.8	309.0
October 30	Marketable	309.8	559.8	293.3	309.8	200.0
	Strings	96.8	77.4	116.1	71.0	100.0
	Total	406.6	637.2	409.4	380.8	300.0

Tenn. Exp. Sta.

[1] Yields and grades seriously affected by vines from larger growing varieties.

Producers in the northern part of the sweet-potato-producing area usually allow the frost to injure the vines slightly before digging. Frosted vines should be cut from the potatoes to prevent decay from starting in the dead vines and passing to the roots. Frosted plants should be dug as soon as possible or loose soil should be turned over the rows to prevent further cold injury. Most growers try to dig sweet potatoes when the soil is dry, as the crop comes out clean and is easier to handle. A plow with a sharp rolling colter and a small mold-board with rods attached is a popular implement for digging. The roots are usually permitted to dry slightly after they have been freed from the soil.

GRADING. Since sweet potatoes require care in harvesting and marketing, and field grading reduces the amount of handling, the marketable potatoes are first picked up, the culls and strings being

gathered later. If the crop is to be stored, it is best to pack the sweet potatoes on padded tables in a shed. The United States Department of Agriculture will supply standard grades for this crop. This is a general standard and a minimum, but many growers prefer to put up a pack that is more than this minimum.

PACKING. The hamper, bushel crate, and barrel are popular commercial packages, while baskets are in common use on local markets. Regardless of the container, it should be clean and neatly packed, and the product should be free from bruises when displayed for sale. The shape of the sweet potato makes it somewhat hard to handle in a jumble pack. Hand placing is justified on some markets. If the pack is only faced, it should be representative of the remaining contents.

CURING. Successful storage of sweet potatoes depends on curing. Kimbrough (Chapter 12) has suggested that this crop can be cured in the lower South by digging in early October and storing in a well-ventilated building. Where a considerable quantity of potatoes were held in a tight building, the heat of respiration, together with fairly high outside temperatures, seemed sufficient for curing. In more northern districts, temperatures of 80° to 90° F. are obtained by the use of additional heat. This treatment causes wounds to heal rapidly and brings about some drying of the roots. The crop should be cured in from 10 days to 3 weeks. United States Department of Agriculture Farmers' Bulletin 1442 gives plans and directions for storage-house construction. Many small-scale farmers construct combination curing-storage houses with poles and mud (Fig. 51). Such structures are inexpensive and practical if properly constructed and can be used for various storage purposes.

STORING. The sweet potato should be stored in a warm building where the air is dry and the temperature uniform. Bins, crates, boxes, or baskets may be used as containers and these should be arranged to provide ventilation. Heat may be necessary to keep the air dry and warm. Injury occurs considerably above freezing.

Thompson advises heating when the temperature drops to 48° F., ventilating at 60° F., and closing ventilators at 55° F. Outdoor cellar houses often are used, but they should have provision for ventilation. Pits and banks lack provision for curing and ventilating, and storage therein often results in heavy loss.

Sweet potatoes should be disturbed as little as possible after they have been cured and stored, as rot is spread rapidly by handling. It is usually necessary to sort stored roots again before selling.

MARKETING. The sweet potato is more plentiful on markets of northern United States than it was a few years ago. Jones and Rosa state that only 3 per cent of the crop of 11 southern states went into carlot shipments in 1922. The northern markets were supplied for the most part by the so-called border states which shipped 45 per cent of their crop at that time. Unless the crop is properly cured, stored, and handled, serious losses occur in marketing. Much of the crop at the present time is handled in trucks. The larger percentage of the supply even on smaller markets is transported in this way.

Northern markets have long been supplied with a dry-fleshed potato such as the Yellow Jersey. The more moist-fleshed varieties are little known. Nancy Hall and Porto Rico have been shipped to some extent, and are increasing in popularity.

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30

TOMATOES

EARL F. BURK, Oklahoma Experiment Station, Contributor

CLASSIFICATION, ORIGIN, AND HISTORY. The tomato (*Lycopersicum esculentum*), a member of the nightshade family, is a native of tropical America.

The large-fruited forms of tomato are reported to have been taken from Peru to Italy, thence to Northern Europe and finally to the United States by 1781. In 1812, tomatoes were commonly on the market at New Orleans. In 1817, tomato seed was first offered for sale in a seed catalogue in the United States, but it was not until about 1835 that the tomato became quite generally cultivated for culinary purposes in the United States, and even at that time there was considerable prejudice against its use. The first tomato fruits grown in the United States were large, oblate, and ribbed. Since 1895, the important developments include (1) improvement of extra-early varieties, (2) development of disease-resistant strains, and (3) breeding and selection of varieties best

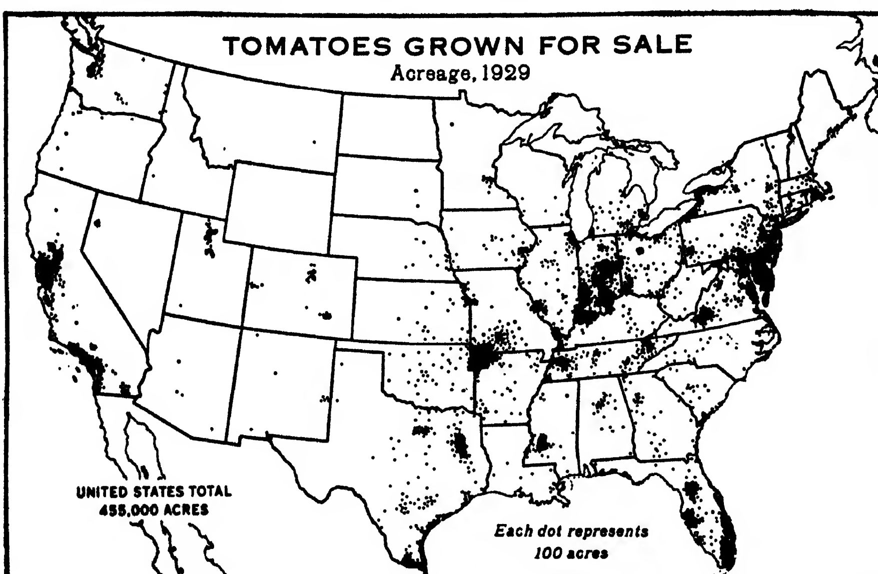

FIG. 124. Acreage and distribution of tomatoes grown for sale.

adapted for specific environmental conditions such as length of photoperiod and intensity of light, soil types, and temperature and humidity.

SCOPE AND IMPORTANCE. The tomato is one of the most widely used vegetables, being surpassed in importance only by sweet potatoes, Irish potatoes, and lettuce. Very few vegetables are so valuable in our diet and lend themselves to so many ways of serving as the tomato. It ranks first as a vegetable for the home garden, for greenhouse forcing, and for a canning crop. The growing of tomatoes on a commercial scale in the South has increased rapidly until now this vegetable is one of the most important truck crops for shipment to northern markets.

The production of plants for northern states is a more recent phase of tomato production which is of considerable importance in the South.

TABLE 55. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF (MARKET) TOMATOES IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION[1]	PRICE PER BUSHEL	FARM VALUE	CARLOT SHIPMENTS[2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Bushels	1,000 bushels	Dollars	1,000 dollars	Cars	By months
Texas	34,001	82	2,782	1.32	3,502	6,137	May–Nov.
Florida	28,266	88	2,494	2.66	6,634	6,752	Mar.–May
Mississippi	10,164	120	1,218	1.45	1,709	2,982	May, June
Tennessee	7,571	113	853	1.13	968	2,025	June, July
Virginia	3,064	124	380	.65	230	176	June, July
Arkansas	2,836	68	193	1.01	170	204	June, July
South Carolina	2,393	71	171	1.80	308	330	May–July
North Carolina	1,700	40	68	1.18	80	95	June, July
Louisiana	1,447	92	133	1.04	138	124	May–July
Georgia	809	73	59	1.51	74	42	May, June
Other States							
California	19,764	120	2,372	1.46	3,470	3,992	June–Nov.
New Jersey	9,543	186	1,779	.69	1,226	233	July
Indiana	5,697	113	645	.81	522	723	Aug.–Oct.
Total (average) for the 27 leading states	157,244	111	17,456	1.31	22,512	26,822	Mar.–Nov.

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.

Many carloads of field-grown tomato plants are shipped annually from Georgia and Texas, to eastern and middle western producing areas.

Table 55 and Figure 124 show the importance and distribution of market tomatoes in southern and other leading states.

CLIMATIC REQUIREMENTS. The tomato is a warm-season plant which requires from 3 to 4 months from the time of seeding to produce the first ripe fruit. It thrives best in clear weather at about 65° to 85° F. The fruit does not become sufficiently red for the U. S. No. 1 grade for canning if the night temperature stays above 85° F.

Plants are usually frozen at temperatures below 32° F., and they do not increase in size at temperatures above 95° F. High temperatures accompanied with high humidity favor the development of foliage diseases.

Hot, drying winds cause the flowers to drop. In the Southwest, where such winds prevail, the tomato field should be protected from the prevailing wind by a stream, woods, or hill. Varieties with pistils shorter than the staminal cone have less blossom drop than others. Irrigation will lower the temperature, raise the humidity, and prevent much of the blossom drop.

Francis C Stokes and Co, Inc

FIG. 125. The Marglobe tomato is wilt resistant and popular in many sections of the South.

AVERAGE PRODUCTION COSTS. The cost of producing tomatoes varies greatly, according to the wide range of conditions under which they are produced. The cost may range from $40 to $120 per acre, depending on fertilizer requirements, pruning and staking practices, availability of cheap labor, and other production factors. Since increased yields usually reduce unit production costs, good early plants and fertilizers are profitable to use along with improved farming methods.

Job 1. Selecting Varieties and Seed

VARIETIES. The importance of good seed of the right variety or strain suitable for the locality cannot be over-emphasized. Some tomato varieties produce exceptionally well under one set of conditions while under other conditions they are worthless. Approximately 90 per cent

of the 400 or more tomato varieties listed in the various seed catalogues are either synonyms or are varieties of little importance. Because of this and the fact that some seed houses continually exploit the public by advertising new varieties regardless of merit, it is good judgment to use a proven variety for the main crop and try out the new varieties with discretion.

TABLE 56. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF TOMATOES

Variety	Chief Use	Season	Plant		Fruit		
			Size and habit	Wilt resistance	Size in ounces	Shape	Exterior color
Bonny Best (John Baer)	home, market	early	medium, spreading	poor	4½–5½	deep oblate	red
Break O'Day	home, market	second early	small, sprawling	good	4–5	globe	red, yellow stem end
Clark's Early	home, market	early	medium, spreading	poor	5–6	deep oblate	red
Earliana	home, market	first early	small, sprawling	weak	4½–5½	flattened	red
Globe	market	mid-season	medium, semi-erect	good	5–6	globular	pink
Greater Baltimore	canning	mid-season	large	weak	6–7	flattened	red
Gulf State Market	home, market, shipping	early mid-season	medium, spreading	weak	5–6	globular	pink
June Pink	home	first early	small, sprawling	weak	4½–5½	flattened	pink
Marglobe	home, market, shipping	mid-season	large, semi-erect	strong	6–7	globular	red
Pritchard	home, market, shipping	second early	medium, spreading	good	4–5	deep oblate	red
Stone	canning	late	large, erect	weak	6½–7½	deep flattened	red
Yellow Plum	home, preserving	early mid-season	medium, spreading	weak	1–2	plum shaped	yellow

In the South, where most of the tomatoes are grown for shipment, the fruits should be smooth, fleshy, medium sized, highly colored, and solid enough to withstand transportation. Globe, Early Detroit, Gulf

State Market, Marglobe (Fig. 125), Break O'Day, and Pritchard are important shipping varieties.

Among the desirable varieties for the cannery are Greater Baltimore, Norton, and Marglobe. For home use and local markets Earliana, Bonny Best, Marglobe, and Pritchard are among the best.

Some of the important varieties are briefly characterized in Table 56.

SECURING SEED. The quality, strain, and trueness to varietal type of seed have such an important bearing upon the yield, earliness, and uniformity of the crop that no pains should be spared in getting the best seed. Some seed firms specialize in producing tomato seed of the highest quality, and have their product certified for purity and freedom from disease. In view of the fact that only 2 ounces of seed will produce sufficient plants for an acre, seed cost should be of secondary importance, provided seed of the best quality is secured.

Job 2. Preparing the Soil

SOIL PREFERENCES. The tomato will grow on nearly all types of soils. A light or warm, well-drained, and fertile soil is best suited to produce early fruit of high quality. The loams and clay-loams have a greater water-holding capacity and are better suited to a longer season of production where large yield and not earliness is of prime importance.

To get the best results from any soil, it is necessary that it contain a good supply of organic matter. The degree of acidity which tomatoes will withstand is increased considerably by a plentiful supply of organic matter. Soils ranging from medium acid (*p*H 5.5) to neutral (*p*H 7.0) are best for tomato production.

PREPARING THE SOIL. Important steps in preparing the soil for tomatoes include (1) removing of diseased plants, (2) disking, (3) applying manure, (4) deep fall plowing, (5) spring disking, (6) harrowing, and (7) floating or rolling if necessary to level or pack the soil. "Well begun is half done" is an old adage that expresses the need and value of thoroughness in preparation.

Job 3. Fertilizing and Manuring

The amount and kinds of fertilizers and manure to apply economically for the tomato crop are dependent not only upon the available fertility of the soil but also upon the organic content, moisture supply, season, cropping system, variety, and the expected returns from the crop.

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FIG. 126. Early tomato plants produce larger and more profitable yields. The three rows to the left were seeded 10 days later and also set in the field 10 days later than those on the right. Photographed 5 weeks after the late ones were set out.

With few exceptions, experiments have shown the following results: (1) Applications of quickly available superphosphate resulted in earlier and increased yields, (2) 4 to 6 per cent of potash in a complete fertilizer is just as effective as 10 per cent on most soils, (3) liming the soil is seldom beneficial, (4) the content of sulfur and its distribution in the tomato plant give evidence that this element is quite important, (5) soils high in humus are better for main crop production, and (6) legume crops are desirable in the rotation.

As a rule, where it is necessary to add nitrogen, phosphorus, and potash, a complete fertilizer containing part of the nitrogen and all of the phosphorus and potash needed for the crop should be applied before planting. Where the plants are to be set close together or where large quantities of fertilizer are used, broadcasting is desirable, but where the rows are to be wide apart or where moderate amounts of fertilizer are used, the fertilizer is best distributed in the rows or in bands near the row. At the setting of the first fruit cluster, a side dressing of 100 to 300 pounds of nitrate of soda or sulfate of ammonia may be desirable. Should the plant show signs of nitrogen deficiency later in the season, additional nitrogen side dressings should be applied, provided that climatic conditions are favorable.

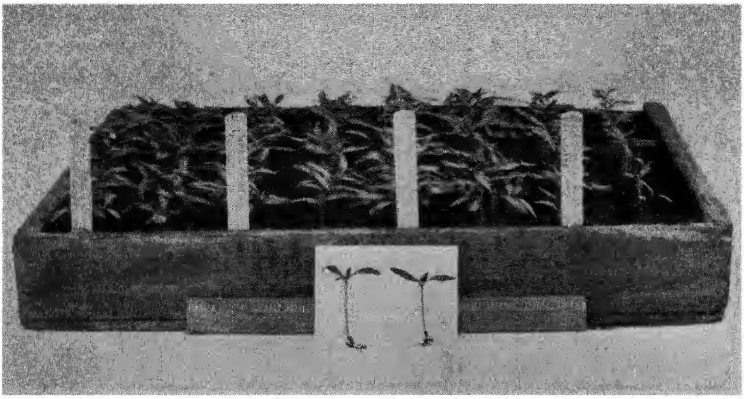

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FIG. 127. Early tomato plants started in a flat. The seedlings are transplanted to other flats, hotbeds, cold frames, paper bands, or pots.

Job 4. Growing and Setting Plants

Early tomato plants produce larger and more profitable yields than late ones (Fig. 126). To secure the early and greater yields it is essential to have large, stocky, disease-free plants with a well-developed root system. For maximum production, the plants should be 6 to 10 inches tall in soil blocks, pots, or other containers at the time of the frost-free date when they can safely be set in the field. The least desirable plants are grown 200 to 300 plants per square foot in the hotbed and then pulled for setting.

SEEDING AND GROWING PLANTS. Plants are either produced by the grower or bought from commercial plant producers as explained fully in Chapter 7.

In the irrigated sections of southern Texas, seed is sown in the summer for a fall crop. The seed is either drilled in an open bed and surface-irrigated or planted in a bed which can be covered by lattice which is placed 18 inches above the soil surface. In either case, the soil must be kept sufficiently moist to produce a good stand and proper plant development.

Many growers produce their own plants, either for small or large planting. In such cases, 2 ounces of seed will produce sufficient selected plants for planting 1 acre. Because of the prevalence of seed-borne diseases which are at times quite serious, it is a good policy to treat the seed with a fungicide before it is sown. Two of the better treatments

are (1) soaking the seed for 1 to 2 hours in a solution of 1 ounce of copper sulfate per quart of water, and (2) thoroughly dusting the seed with 1 level teaspoonful of red copper oxide per pound of seed.

The seedbed soil should be friable, so that it will (1) drain well, (2) not crust, and (3) easily crumble from the seedling roots when plants are removed from the seedbed for transplanting. The addition of sand usually improves the texture. The soil should be free from tomato diseases. Soil not previously used for tomatoes is preferable, but, when it is necessary to use it more than once, it should be sterilized with steam or treated with formaldehyde.

Early plants can be started in the greenhouse, hotbed, flat (Fig. 127), or cold frame, and then transplanted to the hotbed or cold frame, depending upon the seasonal conditions of the location. Eight to 10 weeks are required to produce large plants. Where the seedlings are to be transplanted to produce the large plants, the seed is sown in flats or hotbeds at the rate of 8 to 12 seeds per inch in rows $1\frac{1}{2}$ to 3 inches apart, and is covered $\frac{1}{4}$ to $\frac{1}{2}$ inch.

For later plants which are to be transplanted directly from the seedbed to the field, the seed is sown in the hotbed or cold frame, so that the thinned plants will stand $\frac{1}{2}$ to 2 inches apart in rows 4 to 6 inches apart. Watering should be thorough and preferably limited to mornings of bright clear days.

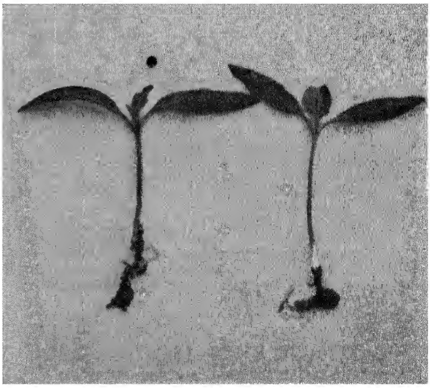

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FIG. 128. Tomato seedlings are at their best stage for transplanting from the seedbed when the first pair of true leaves appear.

TRANSPLANTING. The potting or growing soil differs from the seedbed soil in that it must be fertile to supply nutrients to the growing plants and must be less friable, so that the soil will adhere to the roots in transplanting to the field. A good soil may be made by mixing 4 parts of loam, 2 parts of rotted manure, and 1 part of sand. It is usually well to add $\frac{1}{2}$ pound of the best complete fertilizer for the tomato district in question to each bushel of potting soil.

When the first pair of true leaves appear, 10 to 20 days after seeding,

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FIG. 129. The potted plants are plunged in the soil to prevent excessive drying out. The plants are kept turgid by shading with paper for a day or two.

the seedlings are at the best stage for transplanting into beds or containers (Fig. 128). Plants grown in pots or bands have the advantage of retaining most of their roots when set in the field, but are more expensive than those set 3 or 4 inches apart and grown in cold frame beds, being moved later to the field in soil cubes. Potted plants are plunged into the soil to prevent excessive drying (Fig. 129). It is often necessary to shade the transplanted seedlings for a day or two until the plant is re-established, regardless of how and where they are transplanted.

To produce medium-sized plants in flats, the seedlings are set not to exceed 40 per square foot. For large early plants in the hotbed or cold frame, the plants are set 4 by 4 inches or 5 by 5 inches. The minimum spacing should be 3 by 3 inches.

Regardless of how the plants are grown, they should be hardened to the extent that they will withstand the transfer to outdoor conditions with as little shock as possible. The hardening may be accomplished by lowering the temperature, giving more ventilation, and lessening the water supply. The process may require from 3 to 10 days, depending upon the original condition of the plants. Overhardening, causing the plants to yellow, produces later and lower yields.

SETTING PLANTS IN THE FIELD. A few days previous to setting the large plants to the field from the cold frames, they are blocked

by cutting the soil in squares with a square spade. By blocking previous to setting, the shock is lessened at transplanting. At setting time, each plant is lifted and set out with a 3- to 5-inch cube of soil on its roots.

Plants should be watered moderately a few hours before setting, so as to prevent wilting during transplanting. Watering also aids in removal of the plant from the pot and prevents crumbling of the soil from the roots of either potted or blocked plants.

After the field is thoroughly prepared, it is marked off in both directions, and a lister or small plow is used to open the furrows in which the plants are to be set. Small potted plants are often set with planting trowels. Transplanting machines are used by some for setting plants without a ball of soil on the roots.

The planting distances vary with the locality and the methods of cultivation, from 1½ to 4 feet apart in rows that are from 3½ to 6 feet apart. In setting the plants, it is essential to pack the soil around the roots or root ball. If the soil is not moist, water should be applied. After the water has soaked in, loose soil should be raked or cultivated in, to level the soil about the plants.

Occasionally the plants become leggy in the plant bed. When such plants have to be used for the spring crop, it is best to put the roots not more than 6 inches below the soil surface, then lay the long stem down in the furrow, allowing just enough of the top above ground to bear the first fruit cluster safely above the soil. At this season, the upper 6 inches of soil is warm and contains available nutrients. The buried long stem will take root, resulting in a vigorously growing, productive plant. For the fall crop, which, particularly in the Southwest, must make the early part of its growth during a relatively hot, dry season, a tall plant is often desirable. In setting this crop, the root ball is set as low as 12 to 15 inches in order to reach cooler soil and more abundant moisture. The plant grows slowly at first; then, as moisture becomes more plentiful it produces roots on the covered part of the stem and grows rapidly.

Job 5. Cultivating and Pruning

CULTIVATING. Tomatoes should be cultivated soon after they are set, to stir the soil which has been packed in setting the plants. Early cultivation should be fairly close to the plant, but the succeeding ones should be shallower and farther away, the main object being to eliminate weeds.

If the plants are check-rowed, most of the weed control can be done by cultivation, but where the plants are close together in the row, more

hoeing will be necessary. Weeds permitted to grow not only rob the tomatoes of moisture and plant nutrients, but some of them also are hosts for diseases and insects that attack tomatoes.

PRUNING AND TRAINING. The value of pruning and training tomatoes varies considerably with different localities, seasons, and varieties. Under humid conditions, training reduces losses from soft rot, while, in the drier areas of the Southwest, the trained crop exposed to drying winds is less productive than the untrained plants.

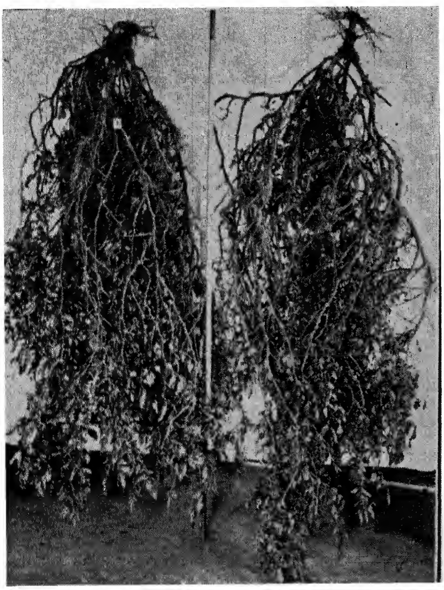

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FIG. 130. The ideal tomato plant type is one with a medium large stem. The small-stem plant at left yielded 6 pounds of fruit while the large-stem plant on right yielded 12 pounds.

The most common practice of pruning and training tomatoes is to prune them to one-, two-, or three-stemmed plants by pinching out the lateral branches as they appear in the axis of each leaf, and then tying the plant to a 5-foot stake driven a foot into the ground about 3 inches from the plant. The pruning should be done shortly after the branches appear. When more than one stem is desired, the larger lower branches are selected and all other branches are next removed. The plants are tied with a soft, strong string by first tying the string tightly around the stake and then making a loose tie around the stem or stems of the plant. Three to four successive tyings about 1 foot apart are required to support the plant properly.

PLANT TYPE AS A GUIDE TO CULTURAL PRACTICES. In order for tomato plants to produce, there must be a certain balance of carbohydrates and the nitrogenous plant foods within the plant. The balance and amount of these foods produce definite plant characteristics. By knowing these characteristics, one can use them as a guide for cultural practices to produce the highest yields.* The ideal plant type

is one with a medium large stem (Fig. 130), a large number of buds per cluster, a healthy green color (depending on the variety), and rapid growth.

A deficiency of some of the soil nutrients can also be detected by certain plant characteristics. A white margin on the leaves of a vigorous growing young tomato plant indicates potash deficiency. A purple under-color on the leaves of the young plant indicates insufficient available phosphorus. The more intense the purple under-color and the slower the plant growth, the greater the phosphorus deficiency. When there is ample phosphorus and potash and the plant is growing slowly with slender stems, the indications are that nitrogen supply is low. Lack of water may be the cause of lack of nitrogen in the plant. Lack of nitrogen is characterized also by a lessening of the number of buds in the newly formed clusters and by the dropping of the unfertilized flowers. In the more severe stages, the terminal vegetative growth ceases and the plants become hardened and yellow-green in color.

It should be remembered that the growing green fruit consumes large quantities of nitrogen. Therefore, as the number and size of tomatoes increase, the nitrogen supply must be increased. To provide for this need, many growers start side dressing with nitrogen as soon as the first cluster of fruit is set. An over-supply of nitrogen is characterized by difficulty in setting the first cluster, rough, fasciated fruits, large succulent stems, and leaves of a light green color, especially at the top of the stem.

Tomato varieties differ in their manufacturing and utilization of the nitrogenous and carbohydrate foods. They also respond differently at different seasons. For maximum production, the grower should know the type of the variety he selects to grow, and then use cultural methods to attain this desired type indicative of high production.

Job 6. Controlling Diseases and Insects

DISEASES. Tomato diseases that are of importance in the South are Fusarium wilt, bacterial wilt, early blight, nailhead spot, mosaic, streak, leaf-spot, root knot, damping-off, bacterial canker, blossom-end rot, sun scald, and puffiness.

Fusarium wilt, caused by the fungus *Fusarium lycopersici*, is one of the most prevalent of the tomato diseases. The disease is characterized by a yellowing and dying of the tomato leaves progressively from the base upward and by the discoloration of the vascular tissue.

The disease is controlled by use of disease-resistant varieties, disease-free seed, seed treatment, disease-free soil in seedbeds, disposal of diseased plants, and rotation. Each grower has a chance to select a wilt-resistant strain by saving seed from the healthiest productive plants in a wilt-infested field each year, but the safest practice is to use seed from selected varieties that are known to be wilt-resistant.

Bacterial wilt is caused by *Phytomonas solanaceara*, a soil parasite which enters the roots through wounds. Insects spread it from one plant to another. The diseased plants wilt during the day and partially recover at night. Freshly cut stems exude a gummy, yellow mass of bacteria.

Control is effected by removing the diseased plants and by rotation.

Early blight is produced by *Alternaria solani*, the same fungus that causes early blight of potatoes. The spores of the fungus may be in or on the seed or may live over in the soil, attacking the plants at any stage of their development.

To control, (1) sow only treated seed from disease-free plants; (2) practice sanitation by deep fall plowing, after burning all plant refuse; (3) set stocky, well-hardened plants early in the season; and (4) spray plants with a 2–3–50 Bordeaux mixture (in terms of hydrated lime) once in the plant bed and every ten days after they are set in the field with 3–4½–50 Bordeaux.

Nailhead spot, caused by *Macrosporium tomato*, is a disease characterized by grayish-brown spots on the fruit, and is controlled by using resistant varieties such as Marglobe, and by spraying with Bordeaux.

Mosaic is a virus disease of major importance in the South because of the large number of perennial weeds which are also the hosts of mosaic. It is highly infectious, and is easily spread by insects and cultural operations. The disease causes a breakdown of the chlorophyll and a mottling and malformation of both leaves and fruits.

To control, (1) keep tomato field and closely adjoining areas free from weeds, especially horse nettles, ground cherries, and poke berry; (2) avoid using diseased seed or seedlings; and (3) keep insects under control, as 50 per cent of the spread is due to insects.

Streak or winter blight is a double mosaic causing necrosis of the young tips and leaves. Control methods are the same as for mosaic.

Septoria leaf spot, associated with *Septoria lycopersici*, appears first as small water-soaked spots on the underside of the older leaves. The older spots have brownish borders with grayish centers. Small, elongated, brownish lesions occur on the stem.

Control methods are the same as for early blight.

Root knot is an enlarged malformation of the roots caused by very tiny nematodes. The nematodes can be starved out by rotating for 2 or 3 years with such crops as Iron cowpeas, corn, oats, velvet beans, and peanuts. Care should be taken to use nematode-free soil in the plant bed.

Damping-off, caused by several organisms, *Pythium*, *Phytopthera*, *Botrytis*, attacks the small seedlings at the surface of the soil, causing the stems to shrivel and the plants to topple over.

The control consists of using fresh or sterilized sandy soil, treating the seeds with red copper oxide, and keeping the small plants and the surface of the soil dry.

Bacterial canker, associated with the bacterium *Phytomonas Michiganensis*, only recently found in the South, is one of the most serious diseases of tomatoes. It is carried on and in the seed.

The first signs are a curling downward of the lower leaves, which begin to wilt and die. Pale streaks appearing on the stems and veins of the leaves crack open, and form cankers. A diseased stem lesion shows a mealy-looking layer of bacteria-filled tissue.

Diseased fruits are spotted first with small white specks, and later have brown spots encircled with a white ring.

The control is the same as that for early blight.

Blossom-end rot is a physiological disease of the fruit, caused by severe changes in moisture conditions which bring about a physiological drought in the fruit, causing the breakdown. The disease appears as a dark brown, leathery rot on the blossom end of the fruit. The rot can be held in check by cultural practices which help to conserve the soil moisture.

Sun scald is caused by sudden exposure of tender green fruits to the sun. Any measure which encourages foliar growth will tend to reduce this malady.

Puffiness is a physiological disease characterized by the failure of the jellylike matrix to form around the seeds. Over-abundance of nitrogen and water, phosphorus deficiency, and mosaic disease are each thought to be causes of different types of puffiness.

INSECTS. Arsenical sprays will control most of the insect pests.

Tomato horn worms and **tobacco worms** are large, green larvae which feed on both tobacco and tomato. They are very easily controlled by hand picking and by arsenical sprays.

The tomato fruit worm (*Heliothis obsoleta*) is also known as cotton-boll worm and corn-ear worm. The young worms feed slightly on the leaves, while larger worms bore into the fruit. Thorough, persistent spraying with lead arsenate reduces the losses.

Cutworms are gray larvae of the *Noctuid* moths. They overwinter in unplowed soil, feed at night, and cut off the tender newly-set plants at the ground level. They are easily controlled by fall plowing and by applying poison bran mash around the plants in the evening. The poison mash is made by mixing 100 pounds of wheat bran, 4 pounds white arsenic, and 8 quarts black strap molasses or other syrup, with enough water to make a stiff mash.

Flea beetles (*Epitrix* sp.) are black beetles about the size of a pin head. Bordeaux and arsenate will either repel or poison them.

Blister beetles (family *Meloidae*) are large, slender beetles of several sizes and colors. They migrate in large numbers and are ravenous feeders. They detect arsenical poisons, but can be easily poisoned with barium fluosilicate.

Job 7. Harvesting, Processing, and Marketing

HARVESTING. The picking basket should be rigid, smooth, not over ½ bushel in capacity, and preferably lined with some sort of cloth for added protection.

The degree of ripeness at which the tomatoes are harvested depends upon the purpose for which they are grown and the time and method of shipping.

For canning and for manufacturing of tomato products, the fruit is fully ripened on the vine. For local markets, it is harvested in the hard ripe and pink stages. But for the bulk of the distant shipments to the northern markets, the fruit is picked in the mature-green stage. There is, however, a considerable portion of the crop picked for shipment in the turning and pink condition. The mature-green fruits are termed green stock and the turning and pink fruits called pink stock by the trade.

The green stock is shipped either without refrigeration on short hauls or with refrigeration on the last part of long hauls exceeding 8 to 10 days. Pink stock requiring over 24 hours in reaching the market is shipped under refrigeration.

DEFINITIONS. Following are definitions of terms used in describing the degrees of tomato maturity:

Immature. Before the seeds have fully developed and before the jellylike cells surrounding the seeds have developed.

Mature-green. The fruit is fully grown and shows a brownish ring at the stem scar after removal of the calyx; the light green color at the blossom end has changed to a yellow-green cast, and the seeds are surrounded with jellylike cells filling the seed cavity.

Turning. About one-fourth of the surface, at the blossom end, shows pink.

Pink. About three-fourths of the surface is pink.

Hard ripe. The fruit is nearly all red or pink, but the flesh is firm.

Over ripe. The fruit is fully colored and soft.

The future of the green tomato industry depends largely upon supplying the trade with tomatoes of high quality. The longer the tomato can be left on the vine before picking for market, the higher will be the quality of the fruit when ripe. The grower should train and supervise his pickers to recognize and pick only the mature fruits. A practical test is to cut a few average tomatoes crosswise with a sharp knife. If the pulp surrounding the seeds is slightly jellylike, permitting the seeds to give way before the edge of the knife without being cut, the fruit is then mature.

RIPENING. Mature-green tomatoes require from 6 to 20 days to ripen in air at 68° to 70° F.

When either storage or field temperatures remain continuously above 80° to 85° F., the fruit does not develop a deep red color. Oxygen is essential for the ripening of tomatoes. Therefore, ventilation is beneficial and wrapping in paper is detrimental to the development of the best quality when transporting and ripening tomatoes.

Some firms satisfactorily employ the use of ethylene gas for ripening and are thereby able to reduce somewhat the time required for this process.

GRADING AND PACKING. Different systems of grading are followed in different parts of the country. The United States Department of Agriculture has established U. S. grades, Numbers 1, 2, and 3, which have been adopted in many localities. The essentials of grading are to eliminate all injured fruits and to separate the sound fruits according to their grade, ripeness, and size. When tomatoes are sold on grade, the careful grower is repaid for his production and careful handling of a high-quality product. Methods of packing vary in different parts of

the country. Regardless of the pack, uniformity always makes it more attractive and demands a better price.

Although the main requirement in packing for shipment is to prevent movement in the package during transportation, there has been too much tendency to overcrowd the containers, thus causing unnecessary cutting and bruising. Research work conducted by carriers shows that 20 to 35 per cent loss in quantity of tomatoes occurs between producer and consumer. Five to 10 per cent of this loss is caused by cuts and bruises in the containers, 5 to 10 per cent never ripen because they are picked while too green, and 10 to 15 per cent rot before ripening.

MARKETING. Three types of sales commonly are made of shipped tomatoes: (1) F.o.b. or trades sales, (2) consignment, and (3) joint account. F.o.b. sales are most desirable and are possible when there is sufficient business at a given point to attract buyers or where grades and business standing have established the confidence of distant buyers. If the markets are glutted and the product is of uncertain quality, consignment then must be resorted to. In shipping on consignment, care should be taken to select a reliable consignment house of high character. When marketing by joint account, the shipper and receiver agree on how the returns shall be divided.

Where co-operative marketing is possible, greater returns may be obtained with less risk by this method.

STORING. Tomatoes can be kept in storage for only a comparatively short time. The best storage temperature at which breakdown is not likely to occur and ripening will take place slowly is between 54° and 59° F. Fruit picked when three-fourths ripe and placed in well-ventilated storage with low humidity and at 34° to 36° F. will keep for about 3 weeks.

For home use, the green-mature fruit picked just before frost and stored in the most desirable place about the premises will give, by sorting every 2 or 3 days, a gradual supply of ripening fruit for approximately 2 months.

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31

WATERMELONS

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CLASSIFICATION, ORIGIN, AND HISTORY. The watermelon (*Citrullus vulgaris*) is thought to be native to Africa, although Carrier has reported evidence of possible American origin. Early French explorers found Indians growing it in the Mississippi Valley. It is reported also as having been cultivated in New England in 1629, and in Florida prior to 1664. However, descriptions indicate that the early American melon was of the citron type and that the true watermelon came originally from Africa. Its culture was unknown in Europe until the sixteenth century.

SCOPE AND IMPORTANCE. Since the days of the early American settlers, the watermelon has continued to increase in importance as a commercial crop until it now has a value of approximately $6,000,000 in the southern states. It is grown for home use and local markets in practically all sections of the country, but Georgia, California, Florida,

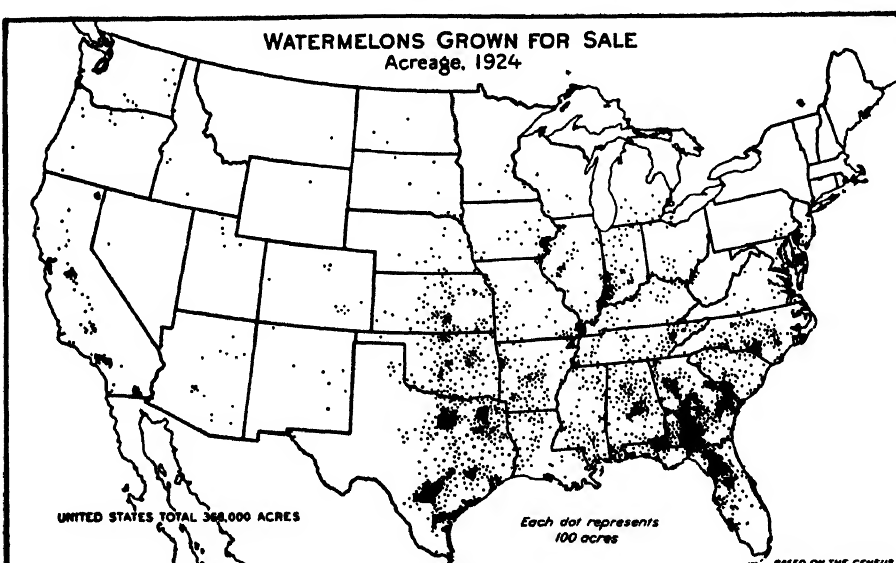

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Fig. 131. Acreage and distribution of watermelons grown for sale.

Texas, and South Carolina in descending order are the heaviest commercial producers of this crop. The relative importance of the principal melon-producing states is shown in Table 57 and Figure 131.

TABLE 57. ESTIMATED COMMERCIAL ACREAGE, PRODUCTION, VALUE, CARLOT SHIPMENT, AND SHIPPING SEASON OF WATERMELONS IN IMPORTANT SOUTHERN AND OTHER LEADING STATES, 1929–1935 AVERAGE

STATES	ACREAGE	YIELD PER ACRE	PRODUCTION [1]	PRICE PER 1,000 MELONS	FARM VALUE	CARLOT SHIPMENTS [2]	PRINCIPAL SHIPPING SEASON
Southern	Acres	Melons	1,000 Melons	Dollars	1,000 Dollars	Cars	By months
Georgia	66,143	272	18,020	82	1,368	15,122	June, July
Texas	33,191	183	6,073	137	729	3,428	June–Aug.
Florida	28,743	268	7,700	209	1,583	6,861	May, June
South Carolina	15,243	281	4,280	88	366	3,776	June, July
North Carolina	7,643	255	1,951	89	174	1,561	July, Aug.
Alabama	6,323	313	1,982	76	151	837	June, July
Virginia	4,391	369	1,621	107	167	812	Aug., Sept.
Oklahoma	3,753	202	758	111	84	203	Aug., Sept.
Arkansas	3,679	265	975	114	111	251	July, Aug.
Other States							
California	16,613	694	11,522	106	1,167	4,718	June, July
Total (average) for the 22 leading states	214,076	294	62,971	113	6,799	40,698	May–Sept.

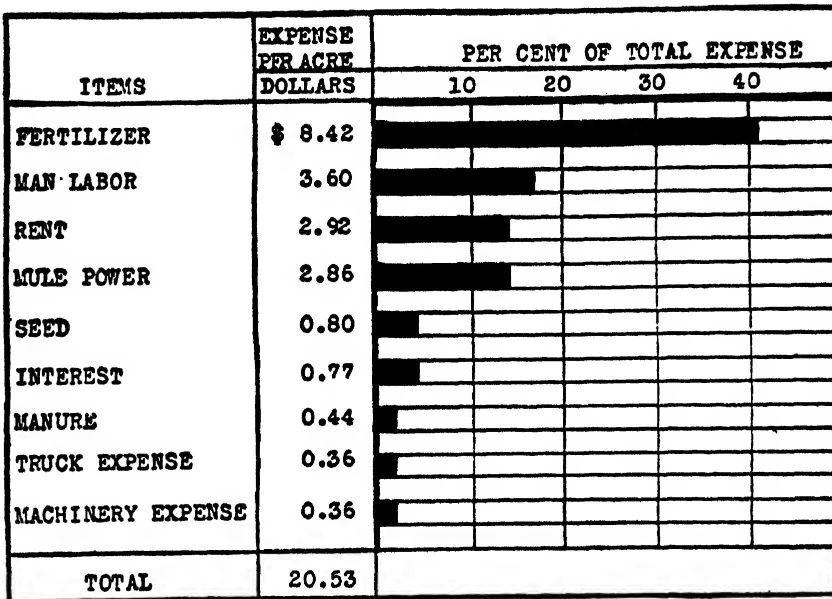
AVERAGE PRODUCTION COSTS. A study of the cost of labor and materials required in producing an acre of watermelons in Georgia showed the following: Man labor, $5\frac{1}{2}$ days; mule labor, $4\frac{1}{2}$ days; seed, 1 pound; fertilizer, 400 to 600 pounds; stable manure, 1 to 3 tons; machinery cost, $1.10.

From a 3-year study of 73 farms, the South Carolina Experiment Station reports an average cost of $20.53 per acre for producing watermelons (Fig. 132). The cost of production will vary from section to section, depending on soil fertility, labor, and other local cost factors.

CLIMATIC REQUIREMENTS. The watermelon requires a long frost-free growing season with relatively high temperatures. It is not

[1] Includes some quantities not harvested on account of market conditions, but excluded in computing values.

[2] Includes boat shipments reduced to carlot equivalent, but excludes motor-truck shipments.



S. C. Exp. Sta. Bull. 301, 1935

FIG. 132. Weighted average cost of producing watermelons in the new truck area, 1929, 1931, and 1932.

highly sensitive to extremes in humidity, and, therefore, it can be grown over a wide range of varying climatic conditions extending from the humid regions of the Southeast to the arid sections of the Southwest. However, leaf diseases are more destructive in humid climates. Normally, the watermelon requires 80 to 120 days to mature fruit, the time varying with the date of planting and the locality in which melons are grown.

Job 1. Selecting Varieties and Seed

Commercial varieties of watermelons may vary in color from gray to dark green; and in shape, from round to long and cylindrical. Varieties having deep red flesh and dark-colored seed are preferred because of popular association of those characters with proper maturity and desirable eating quality. The market demand in the past has been for medium to large melons. There are indications that the greater demand in the future will be for medium to small fruit. Toughness of rind and solidity of flesh, combined with excellent eating quality, are essential factors in a desirable shipping melon, while for home use, quality only is of prime consideration.

VARIETIES. There are many well-known market varieties; however, those more generally grown in the southern states are Tom Watson, Stone Mountain, Dixie Queen (Fig. 133), and Irish Gray. A tabular description of these and other varieties is given in Table 58.

TABLE 58. OUTSTANDING CHARACTERISTICS OF THE PRINCIPAL VARIETIES OF WATERMELONS

Variety	Chief Use	Season	Fruit				
			Size, pounds	Shape	Color and stripe	Flesh color, and flavor	Seed color
Alabama Sweet	shipping	medium early	medium, 20–35	oblong	medium green, mottled	medium red, sweet	cream
Augusta (Georgia) Rattlesnake	shipping	mid-season	medium, 20–35	oblong	light green, mottled	medium red, sweet	black
Dixie Queen (White seeded Cuban Queen)	(promising, new), home, shipping	early mid-season	medium large, 25–40	round	gray, green stripes	deep red, sweet	(small) white
Florida Favorite	home, market	early	small to medium, 20–30	oblong	dark green, light stripe	medium red, sweet	white
Golden Honey	home	mid-season	small to medium, 20–25	oblong	dark green	amber yellow, sweet	brown
Halbert Honey	home	medium early	medium, 20–30	oblong-cylindrical	dark green	deep red, very sweet	white with black margin
Irish Gray	home, shipping	mid-season	medium, 20–35	oblong	light gray, green tinge	medium red, sweet	white
Kleckley Sweet	home, local market	medium early	medium, 25–35	oblong-cylindrical	dark, bluish green	deep red, very sweet	white with brown tips
Klondike	home, local market	second early	small, 20–25	oblong	solid dark green	very deep red, very sweet	black
Stone Mountain (Dixie Bell)	(leading), home and shipping	mid-season	very large, 30–60	oval-round	medium green	deep red, sweet	cream with black margin
Thurmond Gray	home, shipping	mid-season	large, 25–45	oblong-cylindrical	gray, green	deep red, sweet	brown
Tom Watson	(leading), home and shipping	mid-season	large, 25–45	cylindrical	dark green, obscure	deep red, fairly sweet	brown

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FIG. 133. Stone Mountain, Tom Watson, and Dixie Queen are leading watermelon varieties.

SECURING SEED. Purchasing seed from reputable seedsmen should be a universal practice among melon growers. Knowledge of the origin of seed is preferable, so that repeated orders of desirable varieties or strains may be obtained from year to year. Good seed should be viable, true to name, and free from seed-borne diseases, insects, and weed seeds. Commercial seed production is practiced generally in the vicinities of Monticello, Florida, and Rocky Ford, Colorado; however, it is not an uncommon practice for melon growers in the various commercial sections to produce seed in limited quantities.

Job 2. Preparing the Soil

SOIL PREFERENCES. Watermelons thrive best on newly-cleared, sandy-loam soils that are rich in humus, fertile, well drained, and slightly acid. There should be enough litter to provide anchorage for the vines, thus preventing them from being rolled by high winds. It is a common practice in commercial sections to grow watermelons on almost any type of soil that is well drained, warm, fairly productive, and free from injurious insects and diseases. However, it has been observed that, when planted on heavy soils, the plants develop slowly and the size and quality of the fruit are usually inferior.

PREPARING THE SEEDBED. Preparation of the watermelon seedbed should begin well in advance of the planting season. The land should be turned to a depth of 7 or 8 inches during the late fall or early winter to allow ample time for vegetable matter to decay. Just previous to planting, the land should be thoroughly harrowed. The field should then be marked off in checks varying from 8 to 12 feet apart, the distance being determined by the capacity of the land to produce light or rank vine growth. In the southeastern states, a 10- by 10-foot spacing is generally used. In Arkansas and some southwestern sections, spacing approximates or exceeds 12 by 12 feet. After fertilizer has been applied in the row that designates the direction in which the melons are to be cultivated, two furrows are thrown together with a one-horse turning plow, thus providing a slight ridge on which to plant. Seeding on this ridge elevates the plants and affords better drainage.

Job 3. Fertilizing, Liming, and Manuring

Since watermelons normally are grown on the lighter soil types, fertilization is practically indispensable in the commercial production of this crop in the South.

FERTILIZING. All available data indicate that a complete fertilizer is essential for successful watermelon production. The most generally used analysis contains 4 per cent nitrogen, 8 per cent phosphoric acid, and 4 per cent potash. Other analyses in general use include 5–7–5, 6–6–5, 5–8–5, and 4–8–6. The rate of application normally ranges from 400 to 800 pounds per acre. Fertilizer may be applied continuously along the row or it may be placed in a more concentrated position around the plant by extending the application 2 or 3 feet on each side of the hill. If applied directly under the seed, it should be thoroughly mixed with the soil, although there is likely to be less injury to germination if it is placed in furrows 2 or 3 inches on either side of the seed. A supplemental side dressing of a complete fertilizer or about 100 pounds of a 12–0–12 applied at the time vine growth begins, is considered an excellent practice among leading commercial growers in some sections.

MANURING. Because of the general practice of cutting hay from watermelon fields and feeding it to livestock on the farm, practically all barnyard and stable manure in commercial producing areas is contaminated with injurious disease organisms. Such manure, if used for watermelons, is likely to introduce diseases early in the growing season

that will result in serious loss. However, if manure is known to be free of harmful diseases, it is an excellent source of nutrients and humus and may be used to advantage in supplementing commercial fertilizer. The usual rate of application is 2 to 4 tons per acre, applied in the drill in advance of the planting season. There are no data showing the value of green manure in watermelon production, although it is general knowledge that the lighter soils in the South are low in humus content and that increased yields almost invariably result from the use of cover crops. Green cover crops should be turned under about 1 month in advance of the planting season.

LIMING. Since the watermelon is tolerant of the degree of acidity normally contained in the soils in which it is most extensively grown in the South, liming has not been proved essential in the culture of this crop.

Job 4. Planting

STARTING PLANTS IN BANDS. It is not a general practice among watermelon growers in the South to start plants in bands or cups in greenhouses or hotbeds, to be transplanted to the field after the danger of frost has passed. Such practice hastens maturity a few days, and slightly increases production, although it is doubtful if the narrow margin of profit justifies such a practice.

SEEDING IN THE FIELD. Practically all watermelons grown in the South are seeded in the open field. The date of planting in the various sections should be such that the seedlings will appear above ground just after the danger of frost has passed. This may be brought about by planting the seed approximately 10 days to 2 weeks in advance of the average date of the last killing frost. To avoid the possibility of loss from frost injury to earlier plantings, growers frequently follow the practice of making one or two additional seedings at 7-day intervals.

The watermelon hill usually is indicated by intersecting furrows marked off at 10-foot intervals in the field. After the fertilizer has been applied and a ridge has been established, eight to ten seeds are planted in each hill at a depth of $\frac{3}{4}$ to 1 inch. Planting normally is done by hand. Approximately 1 pound of seed is required to plant an acre. The date of planting varies from early February in Florida to the first part of May in the late-growing areas of the South.

Job 5. Cultivating and Weeding

CULTIVATING. The watermelon is a shallow-rooted plant; consequently, shallow tillage should be practiced. Cultivation should

begin soon after the young plants emerge and should continue as long as vine growth will permit. Usually not more than three or four thorough workings are necessary in producing a crop of melons. However, the crop should be cultivated at such intervals as will prevent weed growth. In cultivating, care should be exercised that the vines are not bruised as they are highly susceptible to mechanical injury. It is advisable to turn vines only at the tip as excessive turning is likely to roll the vines and thus cause shedding of the young fruit.

Where the hills have been carefully checked, watermelons may be cultivated in both directions with a harrow or weeder until vine growth interferes. These implements, supplemented with a one-horse cultivator for close work, will reduce the necessity for hand hoeing. After the vines have grown to considerable length, they should be turned into a clearly defined row. This will leave an open space in the middle which will facilitate late cultivation. In Georgia and many of the other commercial producing states, cowpeas are planted in this space and harvested for hay, thereby giving a supplemental crop from the same land.

THINNING AND WEEDING. Where there is no indication of disease or insect injury, thinning of the young plants should begin soon after they appear above ground. It is advisable to reduce the plants gradually to the desired number. At the first thinning four or five of the most vigorous seedlings should be left. These plants should be well distributed in order that proper development may take place. The last thinning should be deferred until the plants are well established and several true leaves have developed. In the final stand, it is a general practice to leave two plants to each hill, but some growers leave only one.

Often it is necessary, when the plants are small, to supplement horse cultivation with hand weeding and hoeing near the hills.

PRUNING. It is customary among producers of high-grade watermelons to prune or thin the fruit in order to obtain a larger, more uniformly shaped melon. Pruning does not mean cutting away the vine but rather reducing the number of melons on the vine. It is generally recommended that two melons be left to each plant or hill. However, in the light of data resulting from a pruning test at the Georgia Coastal Plain Experiment Station, it seems that a better practice, in early-season pruning, would be to remove only melons that are ill-shaped or that have no potential market value. After the early crop is set, subsequent pruning of the late-set fruit should result in an increase in the size of the marketable melons.

The theory involved in pruning is that when the number of melons per vine is reduced, the plant's producing power will be concentrated in a smaller number of fruits, thereby increasing size and perhaps quality.

Job 6. Controlling Diseases and Insects

DISEASES. The leaf, stem, and fruit of the watermelon are attacked by diseases, among the most destructive of which are wilt, anthracnose, root-knot, and stem-end rot.

Wilt, caused by *Fusarium niveum*, is widely distributed in commercial producing areas and is perhaps the greatest menace to watermelon production in the South. It is a soil-inhabiting organism that penetrates the roots and grows up through the water-conducting channels of the stems. The symptoms are a dark brown discoloration in the woody portion of the stem, and sudden wilting of the individual branches, which soon results in the death of the plant.

The disease can be controlled by using wilt-resistant varieties, some of which show commercial promise. Long-time rotations with non-susceptible crops, prevention of drainage water from flowing in from infested fields, and avoidance of the use of stable manure that is likely to carry infestation are factors of importance in reducing losses resulting from this disease. After land has once become infested with the wilt organism, it is practically unfit for future use in watermelon production of susceptible varieties, as the disease has been known to survive from 10 to 15 years in the soil.

Anthracnose. (See page 217.)

Root-knot (Nematodes). (See page 218.)

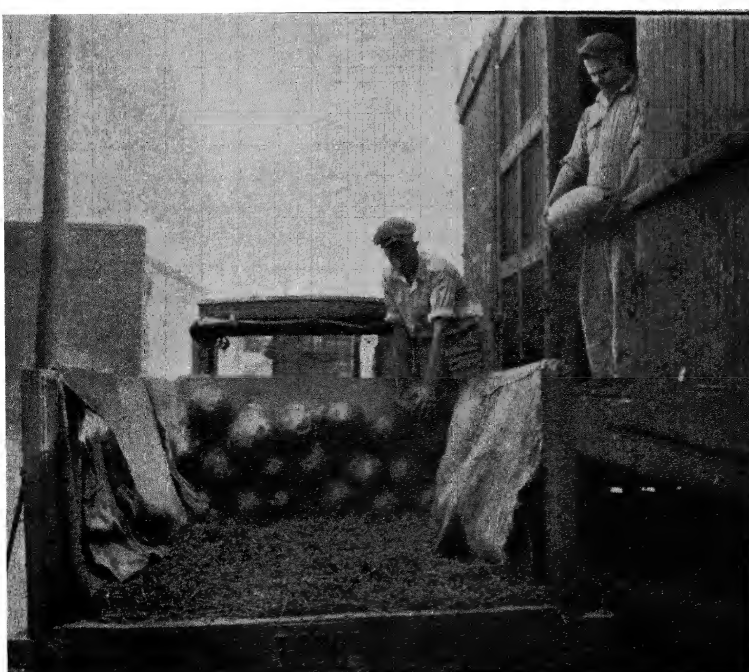
Stem-end rot, caused by a species of *Diplodia*, is primarily a transit disease, and is common and destructive in all sections of the South. Uninjured fruits on the vine are entirely resistant to the disease. Any abrasion on the melon becomes a suitable breeding place for the spores, thus causing infection of the fruit. However, the disease normally enters through the stem. It is effectively controlled by careful handling of the fruit to prevent bruises or scratches and by treating the stem with a paste made of bluestone and starch, as the melons are loaded in the car.

INSECTS. The principal insects attacking watermelons are melon aphids and cucumber beetles. These insects are discussed in Chapter 11 and on page 218 of Chapter 17.

Job 7. Harvesting and Marketing

HARVESTING. Watermelons should not be harvested until they are ripe, as melons do not develop the desired internal color or sugar content if taken from the vines while immature. There is no marked difference in the appearance of green and ripe melons; consequently, only experienced pickers should be used in harvesting. The sound method, which consists of thumping, is generally used. Other indications of maturity are (1) dying of the tendril accompanying the fruit, although this is not a true indication for all varieties; and (2) change in color of the portion of the melon resting on the ground, from a pale white to a creamy yellow.

Melons should be cut from the vines rather than pulled or broken off, and the stems should be left as long as possible in order that they may be reclipped and treated for stem-end rot as they are loaded in the car (Fig. 134).



Ga Coastal Plains Exp Sta

FIG. 134. Padding trucks and wagons to protect watermelons is a common practice among leading growers.

HANDLING. Care should be exercised in handling melons, in order that bruising and scratching may be avoided, as it is through abrasions that the stem-end rot fungus enters. When being carried to heap rows in the field, they should be placed carefully on the ground and trucks or wagons in which they are hauled should be well padded (Fig. 134).

GRADING. Uniformity is an essential factor in marketing watermelons. Consequently, grades have been established which group melons according to weight. The weights of the most generally used grades are shown in Table 59. This table gives also the number of melons per car and the number of tiers of the different grades made by the Sowega Melon Growers Association in loading a 36-foot car.

TABLE 59. WATERMELON GRADES, WITH THE RESPECTIVE NUMBER OF TIERS AND THE NUMBER OF MELONS PER CAR, AS ESTABLISHED BY THE SOWEGA MELON GROWERS' ASSOCIATION OF GEORGIA

Grade (Pounds)	Oblong Melons		Round Melons	
	Tiers	No. in car (36-foot length)	Tiers	No. in car (36-foot length)
20	5	1,350 to 1,450	4	1,300 to 1,350
22	4	1,100 to 1,200	4	1,250 to 1,300
24	4	1,050 to 1,100	4	1,200 to 1,250
26	4	960 to 1050	3	900 to 950
28	4	900 to 960	3	850 to 900
30	4	860 to 900	3	820 to 850
32	4	820 to 860	3	780 to 820
34	4	780 to 820	3	740 to 780
36	4	740 to 780	3	720 to 740
38	4	700 to 740	3	680 to 720
40	4	680 to 700	3	650 to 680

LOADING. Proper loading is highly important in the successful transportation of watermelons to distant markets. Only sound melons with fresh green stems should be loaded. Cars should be clean, ventilated on sides and ends, with walls amply covered with paper and the floor with dry bedding. It is preferable to haul to concentration points where several cars may be loaded during the same day, thereby making it possible to segregate grades. All stems should be recut and treated with bluestone paste as they are placed in the car. In placing melons in the car, sizes should be selected that will give a smooth, tight pack (Fig. 135), as melons that are held firmly in place while in transit reach the consumer in better condition than those that are loosely packed.

Hope Fruit Growers' Assn., Hope, Ark.

FIG 135. Tom Watson watermelons, averaging 36 pounds, firmly stacked four layers deep in a paper-lined, ventilated refrigerator car, according to U. S. standards.

MARKETING. There is an increasing tendency toward co-operative selling among watermelon growers, because of the inability of individuals to obtain proper market information.

The marketing season for southern melons begins in late April in Florida, and continues until early September, when the last of the crop in the upper part of the South is harvested.

Early melons bring the highest price, although the peak of consumption is not reached until the arrival of hot weather in the large consuming centers.

Watermelons normally are shipped from south to north, with the result that few midwestern melons reach eastern markets. California shipments seldom go farther east than Denver.

Practically all long-distance shipments are made by rail, although the use of trucks is increasing. This is particularly true in regard to short hauls.

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32

OTHER VEGETABLES

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A number of those vegetables, which are either grown in restricted areas or which are of less general economic importance, are discussed in this chapter. Special information on the most important phases of culture is included; but the more general practices are omitted, since they are treated in the chapters of Section I. For example, Chapters 9 and 11 discuss cultivation and pest control respectively, and Tables 10, 11, and 12 give information on planting dates, rates, depths, and methods. Since the vegetables are conveniently grouped according to botanical families or growing seasons in Chapter 2, complete information may be found on a related crop in one of the special crop chapters in Section II. For example, Chapter 16 on Cabbage contains considerable information which is applicable to collards, Brussels sprouts, and cauliflower.

For convenient reference, the vegetables in this chapter are arranged alphabetically by their common names.

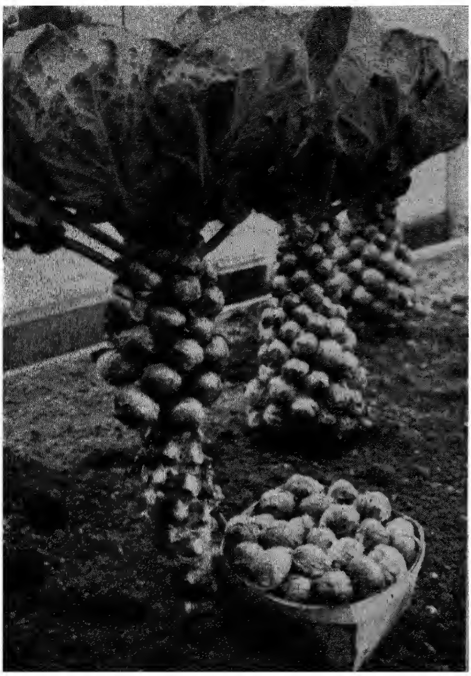
Brussels Sprouts

CLASSIFICATION, HABIT, AND CULTURE. Brussels sprouts (*Brassica oleracea* var. *gemmifera*) is one of the numerous cultivated forms derived from the wild cabbage. The plant is a non-heading cabbage which develops miniature heads (sprouts) in the axils of the leaves. It requires a somewhat longer growing season than late cabbage and must, therefore, be planted in the seedbed and in the field earlier than late cabbage. In other respects, its culture up to harvest is the same as that for autumn or late cabbage. The plant is as hardy as kale. Where kale can be grown as a winter crop, Brussels sprouts should stand. It, like all other cabbages, is a gross feeder and does best on fertile soil.

VARIETIES. There are two general forms of Brussels sprouts, tall growing and dwarf. The dwarf form has been most popular with sprout growers in the United States.

CONTROLLING DISEASES AND INSECTS. Brussels sprouts is susceptible to all the insects and diseases which attack other cabbages.

Among insects, the most troublesome during the warm weather are lice, worms, and the harlequin bug, all of which should be treated the same as when they attack cabbage. Among diseases, club root is the most troublesome. The seedbed should be on sterile soil, and the field for growing the crop should not have been in cabbage, turnips, or other cabbagelike crops for at least 3 years previous to the planting of Brussels sprouts.



Ferry-Morse Seed Co

FIG. 136. Brussels sprouts plant, showing leaves broken away and lower sprouts harvested.

HARVESTING AND PACKING. The sprouts are produced earliest in the axils of the lower leaves of the plant (Fig. 136). When they have attained market size (1 to 1¼ inch in diameter), the lower leaves are broken away and the sprouts are cut off close to the stem with a sharp knife. They are carried in baskets or trays to a packing house and are conditioned for packing in quart berry boxes which in turn are packed in 24- or 32-quart crates for shipment.

From the manner of the growth of the plant, it is evident that there will be several successive harvests from the same plant during the season.

Cauliflower and Heading Broccoli or Hardy Cauliflower

CLASSIFICATION AND IMPORTANCE. Cauliflower (*Brassica oleracea* var. *botrytis*) is the aristocrat of the cultivated cabbages. It is more exacting as to climatic and other environmental condition than any of its relatives. For these reasons, cauliflower culture is carried on only in relatively few favored localities. Records show that the heaviest market supply is offered during November, December, January, and

February each year. The principal sources are California, Colorado, Oregon, and New York. The total shipments from all areas was 7,375 carloads in 1934. Arizona, Washington, Utah, Texas, and Florida have also demonstrated possibilities for production of the crop.

VARIETIES. Varieties appear to have local adaptations. The California industry is based largely on a strain of cauliflower seed produced locally. Little cauliflower seed is produced in the United States outside the local strain mentioned above. Seed can be grown in greenhouses. A forcing strain, the seed of which was also produced in greenhouses, has proved to be a superior outdoor variety in western New York, where it is grown to some extent. Most cauliflower seed used in the United States is of Danish origin and production. Early Snowball and Early Dwarf Erfurt are standard sorts, while Danish Giant or Dry Weather is used in some hot, dry sections.

SOIL AND CULTURAL REQUIREMENTS. The culture of cauliflower should be undertaken only upon very fertile, moist, but well-drained soils. It is essentially a cool-weather crop and should not be planted at a time which will mature the crop in very hot weather.

The production of the plants, the transplanting to the field, and the subsequent handling of the crop up to the time of curd formation is the same as for cabbage. As soon as the heads or buttons appear, care should be exercised to keep them protected from full sunshine, and injury from insects or dirt. Sun injury is guarded against by tying the long outside leaves loosely over the forming heads.

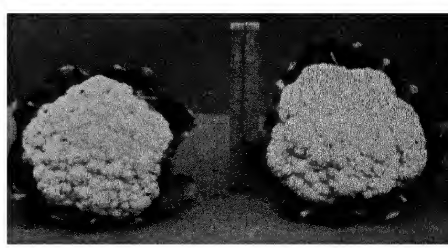


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FIG. 137. Marketable cauliflower heads ready for packing. Three or four whorls of leaves are left and trimmed for protection.

HARVESTING AND PACKING. The growing heads should be inspected frequently, so that they may be cut as soon as they have attained marketable size and before the curds become discolored, loose, or ricy. All off-type or soiled curds should be kept out of the commercial pack. Marketable heads should be cut with three or four whorls of leaves. These should be trimmed so as to leave a circle of leaf petioles about the head long enough to protect it (Fig. 137). The curds should be further protected by covering them with white tea-paper before

packing them in single-layer slat flats or in larger containers. The pack presents a better appearance if heads of uniform size are placed in the same receptacle. The style of package varies with the region and the distance to market, but most commercial growers use crates of some kind.

Cassaba (Winter Muskmelon)[1]

CLASSIFICATION AND HISTORY. Cassabas (*Cucumis Melo* var. *inodorus*) or "winter melons" have been grown in Asia and Europe for a long time, but only within recent years have they become prominent in the United States. The cassabas thrive only in a warm, dry climate, and are grown to some extent in Texas and other adapted southern areas.

HABIT AND CULTURE. The plants are larger and coarser, and the leaves are more deeply lobed than those of the common varieties of cantaloupe. The fruits are either smooth or possess long longitudinal grooves which converge at the stem end. The flesh of the fruit does not have the musky smell of the cantaloupe. This type of melon should remain on the vine until reasonably ripe, being then removed and placed in a cool, dry, well-ventilated place to complete the ripening process. Golden Beauty, Santa Claus, and Honey Dew are recognized winter varieties which are grown to some extent in the South. Cultural methods are similar to those of the cantaloupe, and are fully discussed in Chapter 17.

Chayote

CLASSIFICATION AND IMPORTANCE. The chayote (*Sechium edule*) is a native of Guatemala. The name is a Mexican adulteration of the Aztec name Chayotti and its French equivalent Chayotte. In the Gulf Coast, it is known as the Vegetable Pear, although it grows on a cucumberlike vine and belongs to the cucurbit family. Commercial production of the crop is confined largely to a few localities in Florida. There is marked variation in the color and size of the fruits and in production. Up to the present, however, little has been done to develop and establish desirable prolific strains of chayotes.

SOIL AND CULTURAL REQUIREMENTS. Chayote plants thrive in a rich, moderately-moist, well-drained garden loam, bordering on sandy loam. They can stand excessive moisture for a brief period only. The chayote is a tropical plant, which, when placed in the tem-

[1] Prepared by G. W. Ware, Ark. Exp. Sta.

perate zone with its long hot days, may bear fruit in April and May and again in October and November, but seldom in mid-summer.

The plants are grown from the one-seeded fruits planted early in the season in pots in the greenhouse or in hills 8 by 10 feet apart in the field. The rapid growth of the viny top requires the erection of a trellis or arbor for the support of the plants (Fig. 138). Towards the end of the first season's growth, the plants develop fleshy roots which live over winter. The vinelike tops of the chayote are tender to frost; consequently, the crop does best in localities with a long frost-free season. In those areas where the tops are killed by frost, the roots should be protected by a straw mulch. Planting towards the northern limits of the culture of the plant is done usually in the spring after the danger from frost is past.

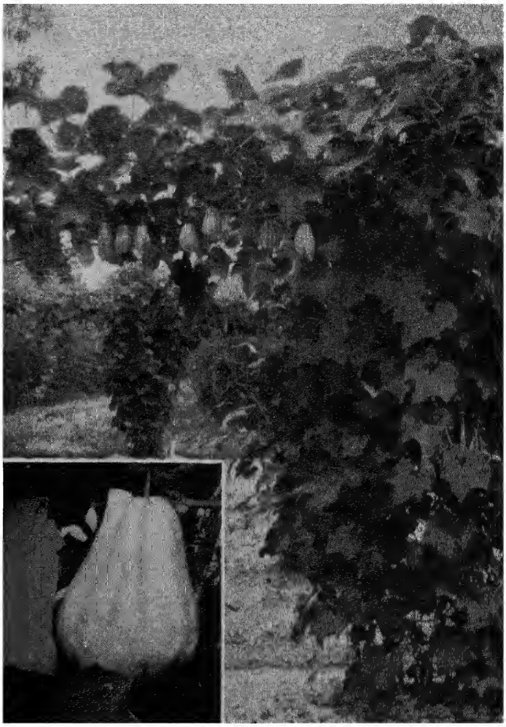

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FIG. 138. A vigorous chayote plant grown on trellis. Inset, close-up of fruit and vine formation.

New plantings usually begin setting fruit in September, and, in about 1 month's time, these fruits will be suitable for harvesting. After fruit setting begins, it will continue until the vines are killed by frost or until fruit-setting is discouraged by hot weather. In general, the most abundant harvest takes place in October and November. Day length seems to be most favorable in the northern hemisphere at that time. In localities where the vine lives over winter, another light crop usually will be produced in April and May. In favorable locations, individual plants have produced as many as 200 fruits. Some plants are prolific and bear over a long period; others are shy producers over a short season.

CONTROLLING DISEASES AND INSECTS. The roots of this plant are subject to the attacks of root knot; the life of the plant, therefore, is determined by the severity of the infestation. Under such conditions annual planting is desirable. Its relation to the squash and cucumber makes it subject to the attacks of all the insect pests of these plants and the same protective measures and remedies must be relied upon.

USES. The chayote is one of the most delicate and distinctive garden representatives of the cucurbit group, and it is deserving of a wider use than it now enjoys as a table vegetable. A much greater use and wider distribution is predicted for this crop as soon as it becomes more generally known on the markets.

Besides being an important and delicious vegetable, the rapidly growing vine lends itself to the decoration of summer houses and arbors.

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FIG. 139. The leaves of chives are used for flavoring.

Chives

CLASSIFICATION AND HABIT. Chives (*Allium Schoenoprasum*) belong to the onion family, closely resembling in form and habits of growth the wild onion or garlic of the southern states. It is supposed to be of European origin. It is a perennial, non-seed-forming plant, and is, therefore, exclusively multiplied by subdividing the clumps which it forms by natural multiplication (Fig. 139). This plant is not grown to any large extent in America, although it is listed in seed catalogs.

CULTURAL REQUIREMENTS. Chives should be planted in rows where it may remain for several seasons. In practice, it is found to do best if reset every 2 or 3 years. In resetting, the compact clumps are lifted and broken into sections of about 25 bulbs each and these are placed in the new locations.

HARVESTING AND USE. The leaves are the part of the plant used, principally for flavoring soups, stews, and omelets. Cutting off the leaves appears to stimulate multiplication of the plants in the clumps.

Collards

CLASSIFICATION AND HABIT. Collards (*Brassica oleracea* var. *acephala*) belong to the cabbage family, and are grown extensively for winter greens from Virginia southward throughout the cotton belt. In these regions the plants are winter hardy.

The collard is a non-heading type of cabbage (Fig. 140). The plant is a gross feeder and frequently attains the height of 3 or 4 feet. Collards, besides being winter hardy, will stand more heat than cabbages and provide a supply of cabbage greens long into the hot weather.

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FIG. 140. Georgia collards are non-heading cabbage and are grown for winter and spring greens in the South.

VARIETIES. The Georgia or Southern and the Louisiana Sweet collards are the important varieties. Some seed companies list a Georgia cabbage collard, which is a cross between a Georgia collard and the Charleston Wakefield cabbage. Claims indicate that it has the hardiness of the collard and the heading quality and flavor of the cabbage, and that heads can be left on the plants all winter and used as needed.

CULTURAL REQUIREMENTS. Seeds may be sown in the spring or in the fall where the plants are to stand or they may be sown in seed beds and transplanted to the field. They are spaced further apart than cabbage in rows 3 to 4 feet apart. The subsequent cultivation is the same as that for kale or cabbage. The leaves are gathered for food as they approach full size, but before they become tough or woody. This process produces a tall bare stalk with a tuft of succulent leaves as its top. Staking is frequently necessary to hold the plants upright.

Cowpeas

CLASSIFICATION AND IMPORTANCE. The cowpea (*Vigna sinensis*) is an important forage and soil-improving crop, extensively grown in the South. It is a member of the great group of legumes of the bean type, and is used for human food both in the green-shelled and dry state. Its ease of culture and ability to grow on poor land makes it an important food crop in the South.

VARIETIES. The variety known as the Blackeye pea is extensively used as a culinary vegetable. Throughout the South and especially in parts of Texas and California, Blackeye peas are grown as a field crop to supply the market demand for the dry shelled product. Brown Crowder and Brown Sugar Crowder are popular varieties on many southern farms. The Whippoorwill, a leading field variety, is used also. The Yardlong bean, one of the cowpeas with seed pods of extraordinary length, is sometimes included in the southern vegetable garden for its edible pod, which is used as a substitute for string beans.

SOIL AND CULTURAL REQUIREMENTS. Although cowpeas respond well to good soil and treatment, they can be grown on poor soil under adverse conditions. As a field crop, cowpeas are frequently sown broadcast, and the pods are gathered when in condition for green or dry shelling. The vines are either cut for hay or turned under as a soil-improvement crop. Approximately 1 bushel of seed is required to plant an acre when broadcast.

Cowpeas are often sown in rows 2½ to 3 feet apart in the same manner as garden peas or beans are planted, using about a peck of seed per acre. The rows are cultivated until the vines overlap. Weeding and thinning are seldom necessary. Although cowpeas have the ability of making a fair growth on poor soil, an application of 200 to 300 pounds of 4–8–4 or some similar complete fertilizer will materially increase production.

Cowpeas are not generally planted as a garden crop, but practically every farm in the South has its so-called pea patch.

Dasheen or Taro

CLASSIFICATION AND IMPORTANCE. The dasheen (*Colocasia esculenta*) is a caladiumlike plant. The starchy corms are the edible portion of this widely-grown tropical arum. It is closely related to and resembles the common, ornamental elephant's-ear (Fig. 141).

The starch content of the dasheen is greater than that of either the potato or the sweet potato. Its protein content is about double and its sugar content about one-half that of the sweet potato. The sugar gives the cooked corm a sweet, nutty flavor, while the large percentage of highly digestible starch, in addition to the protein, renders it a more nutritious food than either the potato or the sweet potato.

This plant is capable, when forced, of providing succulent shoots that may be prepared in the same manner and used in the same way as asparagus, but with a flavor similar to that of the mushroom (Fig. 142).

The dasheen is not a common vegetable in the United States, but is cultivated extensively in tropical America, South China, Japan, and the tropical islands of the world. The use and culture of the plant are probably more highly developed in the Hawaiian Islands than elsewhere.

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FIG. 141. Lifting dasheens by spade and hand.

VARIETIES. The Trinidad dasheen is considered the best of the large number of varieties collected and tested.

SOIL AND CULTURAL REQUIREMENTS. The best environment for the dasheen is a rich, moist, but well-drained, alluvial, silty soil of creek or river bottom. On hammock soils of North Florida a fertilizer carrying 4 per cent nitrogen, 6 per cent acid phosphate, and 10 per cent potash (as sulfate) at the rate of 700 pounds per acre gave satisfactory results. The dasheen is a long-season crop and for that reason is best adapted to the South Atlantic and Gulf Coast states.

Planting should be done as early as conditions will permit, 2 to 3 weeks before the date of the last killing frost. Where the growing season does

not exceed 6 months, it is best to start the tubers or cormels in a greenhouse, hotbed, or cold frame at least a month in advance of the safe season for planting in the open.

Tubers weighing from 2 to 5 ounces each are best for seed; they should be planted 2 to 3 inches deep, 2 to 2½ feet apart, and 3½ to 4 feet between rows. Such spacing will permit horse cultivation early in the season and complete shading of the ground later on. The dasheen is a shallow-rooted plant; therefore, deep cultivation should cease before the roots are injured by the practice.

HARVESTING AND STORING. A plow may be run under the hills in such a way as to turn the corms out of the ground after the tops have been removed. With small lots that must be harvested by hand, two men with long-handled, round-pointed shovels, one on each side of the plant to be lifted, can usually do the work satisfactorily (Fig. 141). After the plants are lifted, the corms must be divided, cleaned, and the so-called tubers or cormels separated from the parent corm (Fig. 142).

Dasheens keep satisfactorily at about the same temperature as sweet potatoes, as far as known; however, they do not require the high temperatures necessary in drying and curing sweet potatoes. As large corms do not keep so well as the

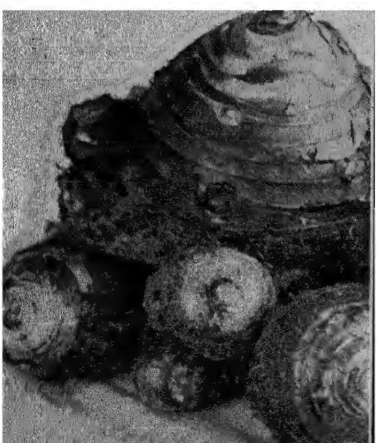

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FIG. 142. Above, blanched dasheen shoots forced from corms buried in sand bed and darkened with heavy burlap. Below, a single hill of dasheens, showing natural position and arrangement of the two corms and numerous cormels, or tubers, with tops and roots removed. The number of corms may be from one to five in a hill.

cormels or tubers, the marketable or edible portion of the crop should be sold without holding too long.

Garlic

CLASSIFICATION AND IMPORTANCE. Garlic (*Allium sativum*) is a member of the onion group, but it differs from the onion in that it consists of a multiple bulb composed of small bulblets called cloves. Nature packs these cloves together in a rough bulblike mass and covers them with a parchmentlike membrane. This package of cloves makes up the garlic bulb of commerce.

Garlic is offered in every market, catering to any considerable population of people from the south of Europe or their descendants. Since garlic is used chiefly for flavoring purposes, a small supply serves for many meals. The demand while important and continuous will never be large. On the other hand, the territory of the United States in which garlic can be grown most successfully is decidedly restricted. As a special crop in the hands of a few growers, it should return a reasonable profit.

VARIETIES. Among garlic growers, two types or varieties are recognized. The one with broad leaves and large cloves is known locally as Creole, Louisiana, or Mexican, and the other as Italian. The latter has narrower and somewhat lighter green leaves than the Creole.

SEED REQUIREMENTS. Since the size of the cloves determines the number of planting units per pound, a sample of the stock to be used for seed should be taken and the average number of cloves per pound determined. From this, one can compute the number of pounds of seed required to plant a given area when the rows are set with plants at a given distance in the row.

There is no package widely used for shipment of garlic. A well-ventilated slat crate serves the purpose best, but the volume in each crate should not be large because there is a tendency to heat when garlic is packed in any considerable mass.

SOIL AND CULTURAL REQUIREMENTS. Garlic thrives best on a friable sandy loam well supplied with organic matter. It often follows cowpeas or soybeans plowed under. In addition to decomposing organic matter, a supplemental application of high-grade fertilizer is usually desirable. In the Gulf Coast states, where garlic is most grown, the land is usually bedded up. If the beds are narrow, the planting is

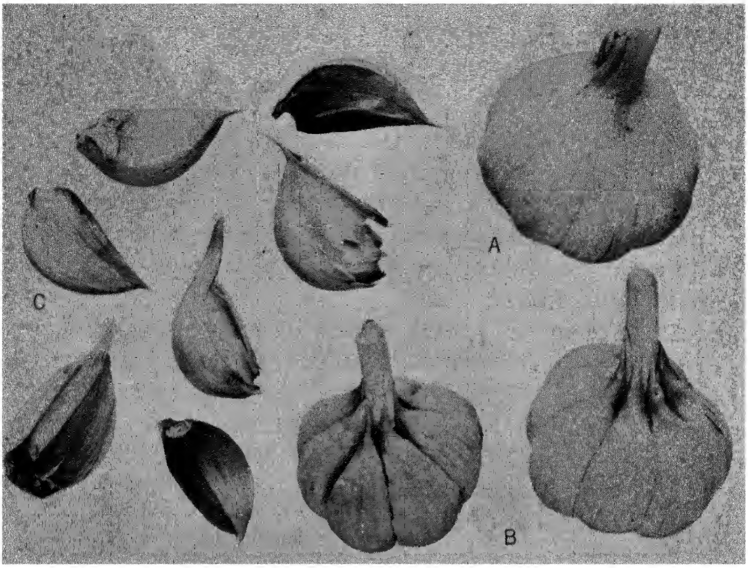

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FIG. 143. A, mature garlic bulb; B, stripped bulb showing arrangement of cloves; C, individual cloves.

made in rows parallel with the bed. If the beds are broad, 15 feet or more, rows may be planted crosswise of the beds. Planting is done by breaking the mother bulbs apart, so that the cloves of which they are composed become individual units (Fig. 143). These units are planted singly, 4 to 6 inches apart, according to variety, in rows 14 to 16 inches apart.

Later cultivation consists in keeping the ditches between the beds as well as the quarter drains open and the crop free from weeds. The soil should not be allowed to form a crust or bake, as it should be loose and friable at the bulb-growth period.

HARVESTING AND PROCESSING. If the soil is very rich, it may be necessary to break over the tops to prevent too much top growth, and to make the bulbs better, as is sometimes done with onions. As soon as the crop is mature, as indicated by the discoloring and wilting of the leaves, the plants should be pulled and placed in windrows, with the tops covering the bulbs to prevent sun scald. After curing for a few days, they are carried to shelves, and later processed for market.

Cleaning garlic consists of clipping off the roots close to the bulb and removing loose outer cover. The plants are then braided or plaited into strings of 50 bulbs each, arranging the bulbs on the outside (Fig. 144). Two strings are usually fastened together to form a double string of 100 bulbs, which is a commercial unit. Some markets use garlic in bulk, which means that the roots and tops are snipped off and the bulbs handled like onions.

While being trimmed and plaited, the bulbs are arranged in sizes. Each string, when completed, carries bulbs of a uniform size and of the same variety. First-class garlic is clean and white, and bulbs with broken sheaths and sprouted cloves are excluded.

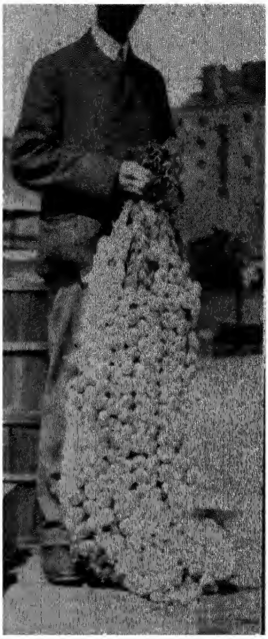

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FIG. 144. Garlic bulbs plaited in double strings, ready for market.

Globe Artichokes

CLASSIFICATION AND IMPORTANCE. The globe artichoke (*Cynara scolymus*) is a robust perennial thistlelike plant, grown chiefly for the edible receptacles and scales of the blossom bud (Fig. 145). It is not hardy to cold, and so its culture is chiefly confined to the South Atlantic and Gulf Coast regions and to the Pacific Coast in California, south from San Francisco to Los Angeles. In the southern and eastern states, the cultivation of the globe artichoke is confined to local market and home gardens. In California, it has gained commercial rank and the market supply largely comes from that state.

SOIL AND CULTURAL REQUIREMENTS. Best conditions for the globe artichoke are obtained on rich friable lands under irrigation. Outside of the irrigated area rich, well-drained soil is best. The plant is a gross feeder and should have from 800 to 1,000 pounds per acre of a high-grade vegetable fertilizer in the form of a side dressing.

Globe artichokes grow readily from seed, but the seedlings are highly variable; hence, only the best specimens should be selected for planting. As soon as the seedlings have shown their character of flower-head, selections should be made. Suckers for replacing discards and for addi-

tional planting should be taken only from plants producing large and desirable blossom-heads.

The plants perpetuate themselves by suckers or offshoots that spring up from the base of the original plant after the blossom stalk has died down. Several sucker plants usually develop about the original crown. It is not desirable to replace the original plant with more than two, or at most three, sucker plants. All in excess of this number from desirable plants may be separated from the parent root with a heel attached by the use of a sharp spade. Such plants may be set in rich, well-prepared, friable loam, and if kept watered until well established, will usually send up a main blossom stalk with 3 or 4 lateral bud-branches the first year after transplanting.

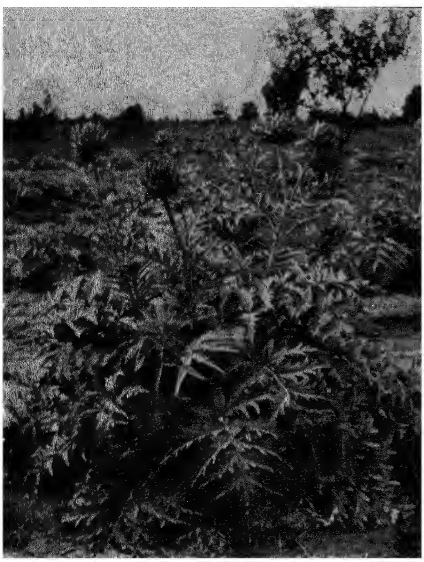

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FIG. 145. Globe artichoke showing edible scales of the blossom bud.

If seedling plants are to be planted, they should be started early in the greenhouse, so as to have large strong plants for placing in the open as soon as favorable conditions prevail. A good guide is to plant them outside at the same time that sweet potato or tomato plants are planted.

CONTROLLING INSECTS. The insect enemies are chiefly two, the artichoke aphid, which may be controlled by applications of 40 per cent nicotine sulfate, 1 to 1,000 parts of water; and the plume moth, the larvae of which bore into the blossom buds, causing considerable loss of the crop in California. Thistles are an alternate host of the plume moth, and they should be kept down in the vicinity of artichoke fields. Nicotine sprays are reported as effective preventives.

HARVESTING AND PROCESSING. As soon as the blossom buds have attained maximum growth, but before signs of flower opening appear, the crop is ready to harvest. There is considerable variation in

time of maturity among plants as well as among the buds on an individual plant; consequently, the harvest season is prolonged and is usually terminated by weather conditions rather than by the exhaustion of the crop.

The mature buds are cut with a short portion of the stem attached, 2 to 3 inches, and packed in cases carrying 1, 2, or 3 dozens each, and sometimes in larger cases of several dozens. Of late, the smaller cases appear more desirable. The heads are assorted into sizes and packed accordingly in flat trays usually in single layers and usually wrapped in white tea-paper.

Horse-Radish

CLASSIFICATION AND IMPORTANCE. Horse-radish (*Armoracia rusticana*) is a well-known garden perennial in many long-established vegetable gardens. It is a near relative of cabbage, turnips, and mustard, belonging to the *Cruciferae* family. Horse-radish is highly prized as an appetizing condiment with oysters and cold meats.

As a commercial crop, horse-radish is grown in but few places. An area about Saint Louis, Missouri, has long enjoyed distinction as the chief horse-radish growing district of the United States.

SOIL AND CULTURAL REQUIREMENTS. The plant will survive in most soils except deep sterile sands and shallow heavy clays with a hardpan subsoil. Best crops are grown on rich, moist, deeply-tilled, friable loams of river bottoms.

Twenty tons of stable manure per acre are turned under the previous fall or in the early spring. Smaller amounts are supplemented by fertilizers carrying 3 to 4 per cent nitrogen; 8 to 10 per cent acid phosphate; and 8 to 10 per cent of potash, applied at the rate of 1 ton per acre.

Horse-radish is grown from root crowns and root cuttings. Most commercial crops are grown from sets or root cuttings. As the crop is prepared for market (Fig. 146) during the autumn and winter, all branch roots as large as or larger than a lead pencil are saved as cuttings. Good cuttings are 6 or more inches long and fairly straight. The bottom of the roots are given a slanting cut and the top end a square cut, which facilitates the work of planting (Fig. 146).

Commercial practices have been highly developed. The land for horse-radish is deeply tilled and plots of uniform length and width are laid off side by side. Furrows 4 or 5 inches deep and 30 inches apart are

laid off the long way of the plots. In order to allow for horse cultivation, experience has demonstrated that the sets are best planted in the furrows in a sloping position, the tops all sloping in the direction cultivation is to proceed. This permits cultivation in one direction in one plot and in

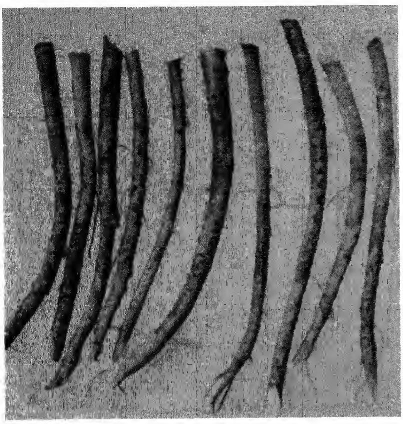

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FIG. 146. Left, branch roots of horse-radish properly cut for propagation. Right, a marketable root.

the opposite direction of the neighboring plot, the idea being to prevent the cultivator from dragging out the sets.

In order to obtain straight merchantable roots, some growers remove the side roots early in the season. This is done by removing the soil and stripping off the side roots from the upper part of the main root. The soil is then replaced. This is usually done twice during the growing season.

HARVESTING, STORING, AND MARKETING. Horse-radish makes its best growth during the cool weather of autumn and early winter. Harvesting should not be started until such growth has taken place. Digging is accomplished with a heavy two-horse plow. A furrow is run along the outside row of roots in the opposite direction from that used in cultivation. A second furrow in the same direction as the first

turns the roots out with the furrow slice. The roots are then gathered and placed in pits or storage cellars, to be prepared for market. Pits, cool cellars, or barns will answer for holding the crop over winter, but roots to be held for summer use should be placed in cold storage.

Preparation for market may be done at any time during the winter when weather permits. The merchantable roots are tied in bundles after all lateral and bottom roots have been removed. The lateral roots suitable for sets are prepared as described above. Yields range from 3,000 to 6,000 pounds of salable roots per acre.

Kale

CLASSIFICATION AND HABIT. Kale (*Brassica oleracea* var. *acephala*) is a winter hardy, non-heading, cabbagelike plant grown for its much-curled and succulent leaves. It was known to the Greeks and was mentioned by Cato in 200 B.C. This potherb is extensively grown in the Norfolk area of Virginia. The plant is bulky and can be grown profitably only in localities enjoying cheap transportation over a short haul.

It is essentially a cool-season crop and does best when planted in late summer for autumn and early winter use.

TYPES. There are two types of kale grown in the United States: One, known as Scotch, has much curled and crumpled foliage of a grayish-green color; the other, called Siberian, is less crinkled and is bluish-green in color. Kale and the closely related collards are favorite plants for the production of winter greens throughout the South.

CULTURAL REQUIREMENTS. Quickly-grown plants are less fibrous and more tender than slowly-grown ones. The soil best suited to such production is friable loam well stocked with organic matter through the use of manure or cover crops turned under and supplemented by the application of a 5–10–5 fertilizer at the rate of about 1 ton per acre. For hand culture, kale is usually planted with a seed drill in rows 18 inches apart, but for horse culture the rows are 24 to 30 inches apart. When the plants are well established, they should be thinned to stand about 6 inches apart in the row. Kale is subject to all the troubles that affect cabbage and the same remedial measures should be employed.

HARVESTING AND MARKETING. For home use, kale is best if harvested before the plants are large and tough, otherwise only the young leaves should be gathered. For market, quickly-grown plants are cut

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FIG. 147. Harvested kohl-rabi plants showing leaves and the edible swollen turnip-shaped stems.

at the surface of the ground and packed in tall hampers or ventilated barrels with burlap covers. Formerly when kale enjoyed the distinction of being the leading green leafy vegetable available during the winter months, it was a profitable crop in the Norfolk and Charleston areas. With an excess of more refined vegetables available at all seasons, kale has strong competition, but it is still extensively planted in the maritime section of Virginia where water transportation is available for reaching important northern markets at small cost.

Kohl-Rabi [1]

CLASSIFICATION AND USE. Kohl-rabi (*Brassica caulorapa*) is grown for the turniplike enlargement of the stem above ground (Fig. 147). It is little known and is not appreciated in the United States, although it is an excellent vegetable if used before it becomes tough and stringy. For good quality, growth must be rapid and unchecked. The plants may be started in the greenhouse or hotbed for an early crop, but the more common practice is to plant the seed where the crop is to mature.

[1] Prepared by H. C. Thompson, Cornell University.

VARIETIES. The most popular varieties are White Vienna, Green Vienna, Purple Vienna, and Earliest Erfurt. The White Vienna is probably grown to a greater extent than all of the others combined.

CULTURAL REQUIREMENTS. The seed is sown in rows 18 inches apart for hand cultivation, or 24 to 30 inches for horse cultivation. The plants are thinned to stand 6 to 8 inches apart in the row. Planting at intervals of 2 to 3 weeks will secure the proper sequence and insure a continuous supply of tender kohl-rabi.

A rich garden soil will produce excellent kohl-rabi. If the soil is not already rich, a liberal dressing of manure is desirable. If manure is not available, green-manure crops and commercial fertilizer may be used as substitutes. A fertilizer similar to that suggested for cabbage would be satisfactory for this crop.

Cultivation similar to that given cabbage or cauliflower is satisfactory for kohl-rabi, but, when it is planted in rows less than 24 inches apart, hand cultivators are used.

HARVESTING. Kohl-rabi should be harvested when the swollen stem is 2 to 3 inches in diameter and before it becomes tough and woody. When prepared for market, the root is cut off and the plants are tied together in bunches like beets, or sold in bulk.

Mustard

CLASSIFICATION AND IMPORTANCE. White mustard (*Brassica juncea*) is grown for salad and greens to some extent, but has been replaced largely by spinach and kale. This plant is a hardy annual of the *Cruciferae* family. The White London is one of the well-known varieties of this species. Black mustard (*Brassica nigra*) is grown largely for its seed which is made into the mustard of commerce. This type is grown to a great extent on the adobe soils in Santa Barbara County, California.

VARIETIES. Giant Southern Curled and Ostrich Plume are varieties of *Brassica Japonica* grown to some extent in the South. Both of these varieties produce large curled leaves. The Ostrich Plume is the most important variety in some sections of the South. Chinese, Chinese Broad Leaf, and Florida Broad Leaf are also extensively planted.

SOIL AND CULTURAL REQUIREMENTS. Mustard is generally sown for greens very early in the spring for spring use, and in the fall for the winter crop. To provide a season's supply, successive plantings

should be made at intervals of 10 days or 2 weeks. Seed are sown in drills 12 to 18 inches apart and the plants thinned as they become crowded in the row (Fig. 148).

On a good sandy-loam soil, 50 to 75 pounds of nitrogen, 100 to 150 pounds of acid phosphate, and 50 to 75 pounds of potash per acre should give good results, even without manure, provided the humus supply is maintained by turning under soil-improving crops. Where manure is used, an application of 25 to 30 pounds of nitrogen and 80 pounds of acid phosphate should be sufficient.

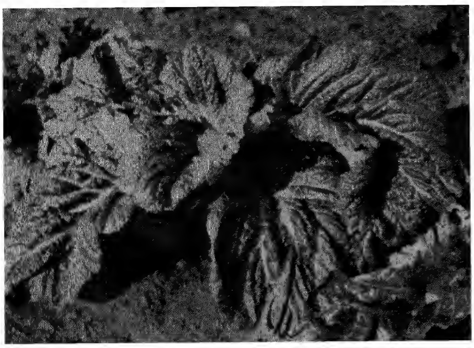

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FIG. 148. Specimen of curled leaf mustard.

In the South, mustard is grown to a considerable extent as a trap crop for the harlequin cabbage bug. It is planted near the cabbage or other crop to be protected and the bugs are collected on the mustard plants. Plants and bugs are killed by spraying with pure kerosene or kerosene emulsion early in the morning when the bugs are inactive.

New Zealand Spinach[1]

CLASSIFICATION AND HABIT. New Zealand spinach (*Tetragonia expansa*) differs from the true spinach in being a much-branched plant 4 to 5 feet across and 1 to 2 feet tall. It belongs to the family *Aizoaceae*. Its leaves resemble somewhat those of the true spinach, but the chief similarity between the two plants is in the flavor. New Zealand spinach lacks commercial importance as compared with true spinach, but it can be a valuable addition to the home garden. Unlike ordinary spinach, it does not withstand low temperatures, but thrives in warm weather, thus extending the spinach season. However, it will not survive the hot summers of the extreme south unless given protection.

CULTURAL REQUIREMENTS. Seed can be planted in warm, protected seedbeds in late winter to be later transplanted, or they may

[1] Prepared by Leslie R. Hawthorn, Texas Experiment Station.

be planted directly in the field when season permits. Whatever the procedure, plants need to be finally spaced 2 to 3 feet in rows 3 to 4 feet apart. Aside from the difference in time and method of planting, the general culture closely follows that for ordinary spinach.

HARVESTING AND GRADING. As soon as the plants are large enough, the tender tips, 3–4 inches long, can be cut off. This stimulates the growth of more branches, and so harvesting continues until some unfavorable condition terminates the life of the plant. Distinct grades for New Zealand spinach have been set up by the United States Bureau of Agricultural Economics.

Okra

CLASSIFICATION AND IMPORTANCE. Okra, or gumbo (*Hibiscus esculentus*), is a popular home garden vegetable in the South. It is thought to be of Asiatic origin and is reported to have been used by the Egyptians in the twelfth century.

VARIETIES. Beattie gives three general types of okra: (1) Tall green, (2) dwarf green, and (3) lady finger. Woodroof recommended the following varieties for Georgia: Dwarf Green, White Velvet, Perkins' Mammoth Long Pod, Dwarf White, and French Market.

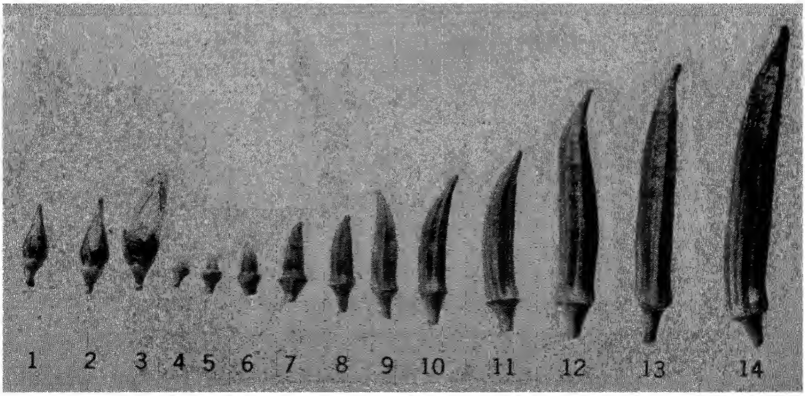

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FIG. 149. **Daily development of okra flowers and pods. The medium-size pods are most edible.**

SOIL AND CULTURAL REQUIREMENTS. Any good garden soil will produce a satisfactory crop of okra if other conditions are favorable. Barnyard manure is desirable for poor soils and a supplementary application of 500 to 1,000 pounds of a 5–10–5 fertilizer per acre will pay under many conditions.

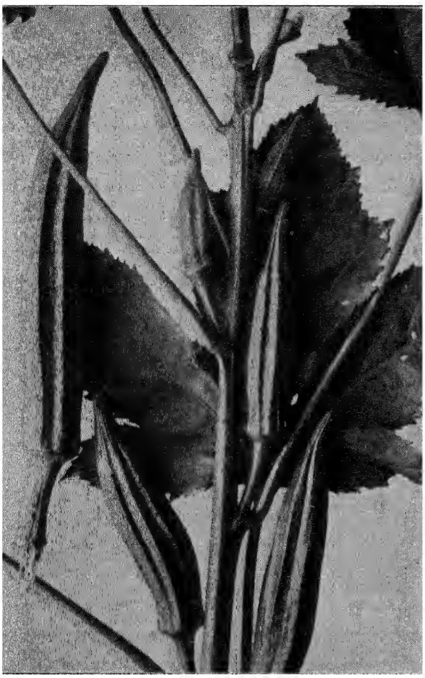
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FIG. 150. Okra plant and pods.

Okra is a tender plant and should not be planted until the danger of frost is over. Seed is drilled thickly on slightly bedded rows $2\frac{1}{2}$ to 4 feet apart. When the plants are established, they are thinned to stands of 12 inches apart for dwarf varieties and 18 to 24 inches apart for the larger varieties. The cultivation of okra should be about the same as for any other cultivated crop. Weeds should not be permitted to become established.

HARVESTING AND USE. Okra yields over a long period of time, usually from June to October. Only the young, tender pods are desired, and should be picked daily to secure a product of best quality (Figs. 149, 150). Okra deteriorates rapidly, and consequently does not ship well.

Okra is used principally in soups and stews. The pods are sometimes stewed and eaten as a vegetable. During late years, some attention has been given to canning okra as well as to developing improved methods of transporting it.

Parsley

CLASSIFICATION AND IMPORTANCE. Parsley (*Petroselinum hortense*), a native of Europe, is a near relative of celery and parsnips. It is the universal favorite for garnishes and is used also for flavoring salads, soups, and stews. There are two types of parsley, one with fibrous roots and finely divided, much curled or crinkled leaves; the

other with plain leaves and fleshy roots which are used for flavoring soups and stews. The leafy type is chiefly grown in the United States, while the fleshy rooted sorts are largely grown in Europe.

VARIETIES. Parsley has been developed with three types of foliage, (1) the plain leaf, (2) the double curled, and (3) the moss or triple curled (Fig. 151). The fleshy-rooted parsley has plain celerylike leaves.

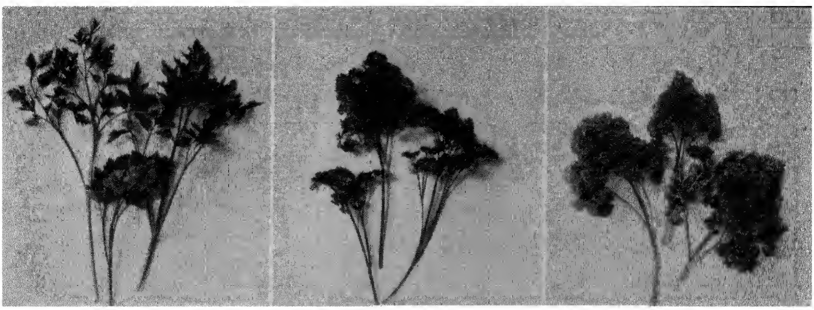

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FIG. 151. Different types of parsley leaves. Left, celery-leaved or plain; center, double curled; and right, moss or triple curled.

SOIL AND CULTURAL REQUIREMENTS. The seed of parsley is small and slow to germinate. Soaking the seed over night induces quicker germination. Young plants are small and quite delicate and require protection and frequent watering to prevent loss from drying. When established, the plants are more resistant to cold than to heat. Because of their tender nature while young, the plants are frequently started in cold frames or hotbeds. Parsley, however, does well under favorable conditions in the open. Rich, fine, moisture-retentive soil is best. In the South, the crop is grown mostly in the autumn, winter, and spring, the summer heat being too severe.

In the North, parsley is grown in greenhouses, cold frames, and hotbeds during the winter months. The Norfolk, Virginia, area grows parsley in sash-and-muslin-covered frames as a winter crop (Fig. 32). The plants can be set about 6 inches apart each way, kept free of weeds, and the entire top clipped off to thicken the crown of leaves on well-established plants.

USE. Parsley is used in a fresh state for garnishing and for flavoring salads, soups, and stews. Dried leaves may be kept for several weeks and are useful for flavoring soups and stews.

Shallot

CLASSIFICATION AND IMPORTANCE. The shallot (*Allium ascalonicum*) is an ancient, universally distributed, onionlike plant. It is believed to have come from western Asia.

PLANT HABIT. The plant is a perennial that seldom produces seeds and therefore must be increased by division of its compound bulbs made up of several bulblets, or cloves, held together at the base. The bulbs are not encased by a sheath as is garlic. The bulblets are planted in the same manner and at the same season as are onion sets, each set developing into a compound bulb. The mature bulbs are harvested, cured, and stored in the same manner as onions. In suitable storage, the bulbs will keep from one season to the next.

USE. The flavor of shallots is somewhat milder than that of onions. The chief use is for flavoring, both leaves and cloves being used.

(Sprouting) Broccoli

CLASSIFICATION AND IMPORTANCE. Sprouting broccoli (*Brassica oleracea* var. *italica*) belongs to the *Brassica* group, and, in recent years, it has become an important addition to the seasonal supply of our cabbagelike vegetables.

Sprouting broccoli does not form a solid head as does cauliflower, which in other respects it resembles. Sprouting broccoli is grown for its thickened flower shoots that arise from the crown and from the axils of the leaves, making a large, loose, short-stalked panicle in some varieties, and finer, taller, flower stalks in others. The shoots may and frequently do bear flowers that are not abortive; the stalks are harvested for eating before flowers open. In other sorts, the flower stalks are fasciated and terminate in club-shaped abortive flower receptacles. Such shoots are usually dark blue-green in color and covered with a heavy bloom.

Sprouting broccoli has gained rapidly in popularity. It is doubtful if any other vegetable as little known has enjoyed such universal acceptance by the buying public and has attained such commercial importance in so short a time.

VARIETIES. Green Sprouting, White Cape, and St. Valentine are prominent varieties.

SOIL AND CULTURAL REQUIREMENTS. Sprouting broccoli does well on any soil that produces satisfactory crops of cabbage. It

can be grown from seed sown in place and thinned out, or with a dropper at proper intervals. The crop may be grown also from plants started in a greenhouse, hotbed, or cold frame, and transplanted to the field at the proper season, depending upon locality.

It requires 100 to 125 days from seed sowing to heading. For the early spring crop in the North, 3 to 5 weeks of this time may be spent in the seedbed. Sowings should be made so as to allow this period of protected growth before the early safe date for placing the plants in the open. An ounce of seed sown in a protected seedbed and handled the same as early cabbage should supply from 3,000 to 4,000 plants. The field handling of the crop up to harvest is the same as for cabbage.

HARVESTING AND USE. The tips of the flower stalks with or without the partly developed flower buds are harvested, and tied in bunches. The bunches vary from a fraction of a pound up to 1 to 2 pounds each.

The distinctive flavor and the green color of the product along with the vitamin content of the chlorophyll-laden shoots make a strong appeal to the appetite, and add variety to the supply of succulent vegetables.

Soybeans

CLASSIFICATION AND IMPORTANCE. The soybean (*Glycine Max*) is a close relative of the cowpea. As a garden crop, it has not been generally cultivated in England or in the United States. In Japan and in Manchuria, it is a food crop of first rank and of prime importance.

VARIETIES. The varieties of soybeans are exceedingly numerous and they vary greatly in time of maturity, color, and quality. They vary from 75 to 170 days in maturity; similarly, they vary in flavor, ease of cooking, and soil and climatic adaptation. The Japanese have developed many sorts, used exclusively as garden beans. For graden purposes, the Hahto and Easy Cook are commonly used.

SOIL AND CULTURAL REQUIREMENTS. Soybeans do well under the conditions suitable for ordinary garden beans. They should be planted in rows 24 to 30 inches apart and the seed distributed, so as to insure a stand of plants 3 to 4 inches apart.

The time of planting in the North is immediately following corn planting, and in the Gulf states the best time is from April 15 to June 1.

Soybeans are not so sensitive to frost as are garden beans and may be planted somewhat earlier.

HARVESTING AND USE. Soybeans as a green vegetable should be harvested when the seeds are fully grown, but before they have hardened, as the pods are rough, hairy, and hard to shell. The young beans resemble young lima beans, but have a richer nutlike flavor. Tough pods, if boiled for about 3 minutes, may be shelled with comparative ease. Cooked immature soybeans are a rich source of protein, fat, calcium, phosphorus, and iron, and are also good sources of vitamins A and B, but are a poor source of vitamin C.

Soybeans are not a favorite food of the Mexican bean beetle, and can be grown in localities where this insect prevents the culture of bush beans. Japanese beetles and rabbits are fond of soybeans, however.

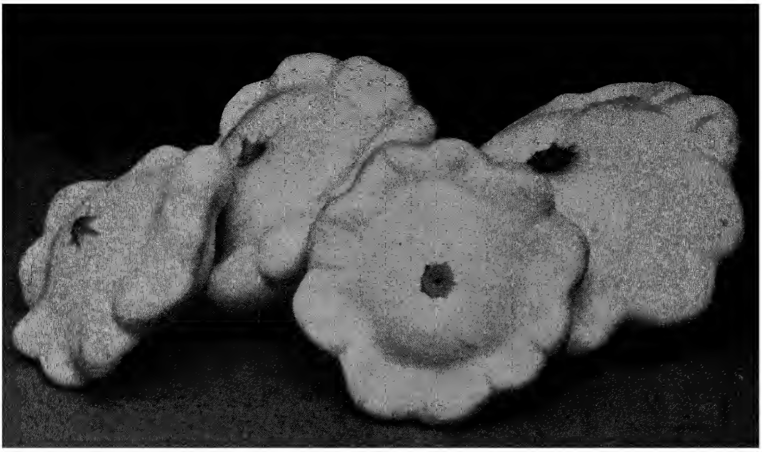
Soybean flour has long been used in making bread and cakes for diabetics, because of its low starch content. Soybean milk is extensively used as infant food and as a means of restoring normal flora in the digestive tract. As a food, it is non-acid forming.

Squashes and Pumpkin

CLASSIFICATION AND IMPORTANCE. The plants spoken of as squashes and pumpkins comprise no less than three species of the genus *Cucurbita*, namely *C. pepo*, *C. maxima*, and *C. moschata*. The nomenclature of this group of plants is greatly confused because the popular name "pumpkin" is used for that part of the species *C. pepo* having strong-growing viney plants bearing relatively large fruits with tough skins, and the name "summer squash" for another group of varieties of *C. pepo*, such as scallop (Fig. 152), patty pan, summer crook-neck, and Italian marrow or Cocozelle (Fig. 153).

The *moschata* group is likewise made up of the so-called Canada Crook Squash or Cushaw and the Pie Pumpkin. It thus appears that there are forms of *C. pepo* called pumpkins and others called squashes, and that in *C. moschata* there are also pumpkins and squashes. All varieties of *C. maxima* are squashes. Squashes may be *C. pepo*, *C. moschata*, or *C. maxima*. Pumpkin may be *C. pepo* or *C. moschata*.

For generations, the place of origin of pumpkins and squashes has been a matter of doubt. Archeological investigations conclusively prove that pumpkins, squashes, and gourds were widely distributed both in South America and North America, and were extensively used by the people of the Americas for receptacles, utensils, and as food, long before these continents were discovered by Columbus.



Ferry-Morse Seed Co.

FIG. 152. White Bush Scallop, a popular southern summer squash.

Summer squashes are extensively grown by truck farmers in the trucking sections of the southern states. They are also grown in nearly every home garden as well as market gardens throughout the country. The hard-shelled, long-keeping sorts, such as Hubbard and Pikes Peak, are chiefly grown in the northern states, New England, and New York in the East; Michigan, Wisconsin, and Minnesota in the Middle West, and Colorado in the West.

SOIL REQUIREMENTS. Soil requirements are similar for all squashes and pumpkins. Any well-drained, friable loam, well supplied with nutrients and well stocked with humus, will produce a satisfactory crop of squashes and pumpkins if other conditions are favorable.

Bush sorts may be planted in rows 6 feet apart with the hills containing 4 to 5 plants, spaced 4 feet apart. The large-fruited, viney types should be planted in hills 8 by 8 feet apart and with seed enough to insure 3 to 5 plants to the hill. Clean culture and protection from squash bugs and borers are essential to success.

HARVESTING, STORAGE, AND SHIPMENT. The summer squashes are all harvested while immature and while the shell is soft and easily cut by the thumb nail. If the fruits reach full size and the shell begins to harden, they are of no culinary value. The squashes of the

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FIG. 153. General planting of Cocozelle squash, showing fruit in baskets

C. maxima and *C. moschata* groups, as well as the pie and stock pumpkins, should be well matured before harvest, but should not be exposed to frosts if they are to be stored for winter use.

Hard-shelled sorts, like the Hubbard and Vegetable Marrow, when well matured may be stored on shelves in frost-free rooms at a temperature around 50° F. for several months. Fruits intended for storage should be handled with great care, so as to avoid bruises or wounds that break or scratch the skin, or break off the stems of the fruit. The fruits should be removed from the vine by cutting the vine but not the stem of the fruit.

Summer squashes are generally shipped in tall stave hampers; however, some sections use bushel baskets or lug boxes. They should be packed tightly to avoid jostling and bruising in transit. The hard-shelled winter sorts are usually packed in ventilated stave barrels.

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33

HOME VEGETABLE GARDEN

CLAUDE WOOLSEY, Formerly, Arkansas Extension Horticulturist, Contributor

The importance of the home garden for the average southern home cannot be overestimated. It has been correctly stated that the home vegetable garden is the most valuable crop grown on the farm, when all factors are considered (Fig. 154).

Vegetables supply an essential need in the diet. The various vitamins and essential salts found in vegetables make them invaluable for the human system (Table B, Appendix).

The home vegetable garden should furnish an ample supply of fresh vegetables throughout the growing season and a surplus of those vegetables desired for canning, drying, and storing for use during the winter. By proper selection and succession of crops, fresh vegetables may be had from the garden most of the year in many parts of the South.

Planning and Arranging

CHOOSING A LOCATION. Very little can be said in regard to location of the garden, as the location of the house and various other permanent structures, to a degree, determine the garden site. However, where possible, the garden should have a location convenient to the kitchen and one that affords the maximum amount of sunlight. Also, frost is less likely to injure vegetables on high ground than on low ground or in valleys, and a southern exposure and sandy loam will produce earlier vegetables than a northern exposure and a heavy soil. It should be remembered, also, that a fairly level place, if properly drained, is desirable.

SELECTING SOILS. A good garden soil is one that carries an abundance of nutrients, is of open texture, is well supplied with humus, and is properly drained. It is necessary on most soils to add fertilizers, animal or green manures, and in some cases, lime and water. A large quantity of well-rotted vegetable matter adds nutrients to the soil, improves the texture, aids in the growth of beneficial bacteria, holds moisture, and helps to set free nutrients which are already in the soil but not available.

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FIG. 154. The home garden affords profit, health, and pleasure to all members of the family.

DETERMINING SIZE. In the South, it has long been the practice to grow sweet potatoes, canning tomatoes, and other large and bulky vegetables in locations other than in the vegetable garden. In this case, the garden nearest the house is a kitchen garden and the field garden may be in some well-chosen fertile location on the farm where the necessary care may be given with the team and field-cultivating tools, while the farmer is in the field for the general crop work. As a convenience to the housewife, however, crops which need frequent harvesting, such as tomatoes and beans, should be in the kitchen garden or near by.

A garden 100 by 150 feet containing approximately $\frac{1}{3}$ acre of land will furnish enough vegetables for a family of five. Since the discussion in previous chapters covers, in the main, the problems encountered in field production, this chapter deals with the kitchen garden located at or near the house.

PLANNING AND ARRANGING. A planting plan of the garden furnishes the grower with a record of the variety and amount he wishes to plant, the succession of crops, and other worth-while information necessary for proper management of the garden. In order to plan

Table 60. Suggested Plan and Arrangement of a 100- by 150-Foot Home Garden

Distance between Rows	Kind, Amount, and Succession of Crops: Spring planting	Kind, Amount, and Succession of Crops: Summer or fall planting	Distance between Rows
6 ft. Hot-	Cold Asparagus		4 ft.
3 ft. beds	Frames Parsley Horse Radish Rhubarb	(Adapted only to the mountain regions of the South)	4 ft.
3 ft.	Radishes, 50 ft. — Lettuce, early, 50 ft. — Beets, 50 ft.	Followed by Bush Beans	3 ft.
3 ft.	Peas, early	Followed by Blackeye Peas	3 ft.
3 ft.	Peas, late	Followed by Blackeye Peas	3 ft.
3 ft.	Onion, sets	Followed by Radishes and Lettuce	3 ft.
3 ft.	Beets, Medium, 100 ft. — Carrots, early, 50 ft.	Followed by Fall Cabbage	3 ft.
3 ft.	Early Cabbage, 100 ft. — Cauliflower, 50 ft.	Followed by Bush Beans	3 ft.
3 ft.	Onion, seeded		3 ft.
3 ft.	Onion, seeded		3 ft.
3 ft.	Early Potatoes	Followed by planted Onions	3 ft.
3 ft.	Early Potatoes	Followed by planted Onions	3 ft.
3 ft.	Early Potatoes	Followed by planted Onions	3 ft.
3 ft.	Swiss Chard, 50 ft. — Salsify (Oyster plant), 100 ft.		3 ft.
3 ft.	Parsnips		3 ft.
3 ft.	Carrots for winter		3 ft.
3 ft.	Late Beets for winter		3 ft.
3 ft.	Beans (bush)	Followed by Scotch Kale	3 ft.
3 ft.	Beans (bush)	Followed by Spinach	3 ft.
3 ft.	Beans (Lima)	Followed by Fall Cabbage	3 ft.
4 ft.	Tomatoes, early	Followed by Fall Cabbage	4 ft.
4 ft.	Tomatoes, early — Peppers — Eggplants	Followed by Turnips	4 ft.
4 ft.	Tomatoes, late	Followed by Turnips	4 ft.
4 ft.	Sweet Potatoes		4 ft.
4 ft.	Sweet Potatoes		4 ft.
4 ft.	Cucumbers	Followed by Turnips	4 ft.
4 ft.	Squash (summer and winter)		4 ft.

definitely, the length and breadth of the garden should be determined or measured and drawn to scale on a piece of white paper. A convenient scale is $\frac{1}{8}$ inch to a foot. Accordingly, a garden measuring 100 by 150 feet would require a drawing $12\frac{1}{2}$ by $18\frac{3}{4}$ inches. The kinds of vegetables and dates of planting can then be placed in the proper position on the plan. The plants should be grouped so that those needing the same cultural treatment may be together in the same section of the garden (Table 60).

The garden will have in general three main divisions, namely: (1) Perennial section, (2) all-season section, and (3) part-season section. The last two named divisions may be subdivided into cool- and warm-season crops. The perennial crops should, of course, be located at one side of the garden where they will not interfere with other garden practices. The all-season crops, such as parsnips, cucumbers, and tomatoes, should be located so as not to interfere with the successive or succession planting as indicated in the plot. The part-season crops, such as beans, beets, peas, and lettuce, should be grouped together to allow a large section of the garden to be vacated as the crops mature. This permits the preparation of the land and the planting of succession crops (Fig. 155). The plans include only suggestions for a farm garden. Many other plans

FIG. 155. A well-planned garden groups similar vegetables in rows long enough for convenient cultivation.

might be drawn which would serve the individual taste and desire of the grower, especially as to quantities to plant.

Cultural Practices

CULTURE. Since the preparation of seedbed, plant growing, fertilization, cultivation, disease and insect control, and other necessary

TABLE 61. APPROXIMATE HARDINESS, PLANTING DATE, AND TIME REQUIRED TO RAISE VEGETABLES IN THE MIDDLE SOUTH[1]

VEGETABLE	HARDINESS	TIME TO PLANT	TIME READY FOR TABLE
Bean, bush	Tender	Mar. to Aug. 15	45–60 days
Bean, pole	Tender	Apr. to Aug. 1	60–80 days
Bean, bush lima	Very tender	Apr. to July	60–75 days
Bean, pole lima	Very tender	Apr. to July	60–80 days
Beet	Semihardy	Mar. to Sept. 1	60–80 days
Cabbage, plants, early variety	Hardy	Feb. to Apr.; July, Aug.	90–110 days
Cantaloupe	Very tender	Mar. to June	90–110 days
Carrots	Semihardy	Feb. to Sept.	75–100 days
Celery	Semihardy	Feb., Mar., Aug.	120–150 days
Corn, sweet	Tender	Mar. to Aug.	60–100 days
Cowpea	Very tender	Apr. to June	70–100 days
Cucumber	Very tender	Apr. to Aug.	60–80 days
Eggplant, plants	Very tender	Apr. to July	60–70 days
Kale	Hardy	Feb. to Oct.	90–120 days
Lettuce	Semihardy	Feb. to Sept.	60–90 days
Mustard	Hardy	Feb. to Oct.	30–60 days
Okra	Very tender	Apr. to July	90–120 days
Onion, plants	Hardy	Dec. to Apr.	40–150 days
Parsnip	Semihardy	Feb. to Aug.	125–160 days
Pea, English	Hardy	Feb. to Aug.	90–120 days
Pepper, plants	Very tender	Mar. to June	90–100 days
Potato, Irish	Semihardy	Feb. to Apr.; July to Sept.	75–100 days
Potato, sweet	Tender	Apr. to June	125–150 days
Pumpkin	Very tender	Apr. to July	90–120 days
Radish	Semihardy	Feb. to Oct.	25–40 days
Rutabaga	Semihardy	Feb. to Oct.	60–80 days
Spinach	Semihardy	Jan. to May; Sept. to Oct.	30–60 days
Squash, summer	Tender	Apr. to Aug.	60–80 days
Swiss chard	Semihardy	Mar. to Sept.	45–60 days
Tomato, plants	Tender	Apr. to Aug.	80–150 days
Turnip	Hardy	Feb. to Oct.	60–80 days
Watermelon	Very tender	Apr. to July	90–120 days

[1] Prepared by D. C. Mooring, Okla. Ext. Horticulturist.

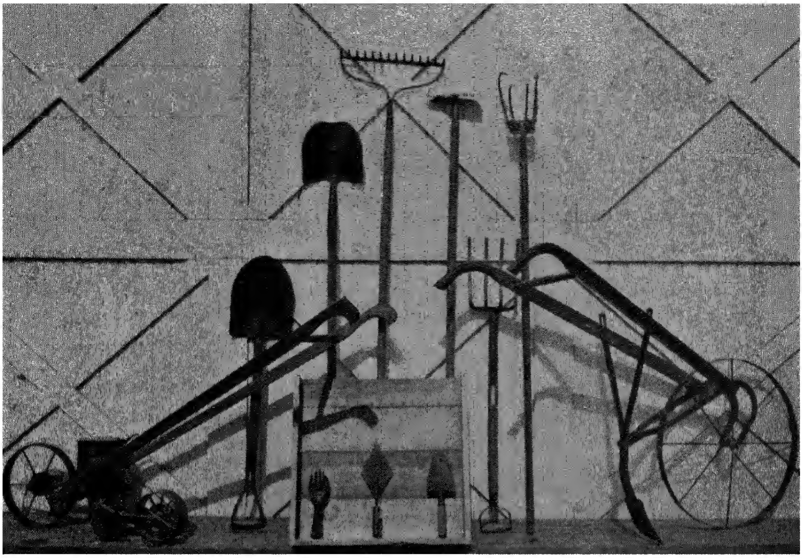

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FIG. 156. A set of handy garden tools.

operations are discussed fully in preceding chapters, they will not be reviewed here. The home garden, like a commercial crop, should receive every necessary attention to make it productive and profitable. Vigilance and careful planning are necessary for success. Proper working facilities such as accessibility, protection, moisture regulation, adequate tools (Fig. 156), and simple storage space are well worth providing.

PLANTING SCHEDULE. Some vegetables mature in a short time, while others need the entire season to reach maturity. A good plan aids the gardener in grouping such plants for the convenience of planting, cultivating, and disposal. Table 61 lists the relative hardiness and approximate time to plant and harvest.

Valuable planting information is given in Chapter 8. Table 10 gives full information on the quantity of different seed needed and method and depth of planting. Figures 36 and 37 show average dates for the latest killing frost in the spring and the first killing frost in the fall, respectively; while corresponding Tables 11 and 12 provide spring and fall planting dates for different sections of the country.

Choosing the Kinds and Variety of Vegetables to Grow

The kind and variety of vegetables to grow will of course depend on the individual tastes of the family. Varieties should be chosen to meet special requirements, such as earliness, succession, adaptability, disease resistance, and productivity. The experiment stations of the state colleges of agriculture will supply lists of the varieties best suited to the several states. A complete list of home garden references appears at the end of this chapter. Table 62 gives an alphabetical list of the leading varieties of the different kinds of vegetables grown throughout the South.

Choosing the Kinds of Herbs to Grow

Every southern garden should contain some of the herbs used for their flavor and fragrance in cooking. Herbs are annual, biennial, or perennial. Most of them should be planted in the perennial section of the garden.

A few plants of the following herbs will supply the average family:

Anise (*Pimpinella anisum*). Seed used in medicine, cooking, and for flavoring liquors (annual).

Balm (*Melissa officinalis*). Leaves used for their lemonlike flavor in liquors and medicine (perennial).

Basil (*Ocimum basilicum*). Clove-flavored foliage used in flavoring meats, soups, and salads (annual).

Borage (*Borago officinalis*). Coarse leaves sometimes used as pot-herbs and for seasoning salads (annual).

Caraway (*Carum carvi*). Seeds used in making bread, also cheese, salads, sauces, soups, candy, and cakes (biennial).

Catnip (*Nepeta cataria*). Leaves used in making sauces and teas; a mild condiment (perennial).

Chive (*Allium Schoenoprasum*). Leaves used for flavoring; belongs to the onion family (perennial) (Fig. 139).

Coriander (*Coriandrum sativum*). Seed used in making confections and bread (annual).

Dill (*Anethum graveolens*). Stems and blossom heads used for making dill pickles and flavoring soups (biennial).

Fennel (*Foeniculum officinalis*). Used in French or Italian cookery; stems sometimes used raw (biennial or perennial).

Horehound (*Marribium vulgare*). Used in tea and for flavoring sugar candy; supposed to be good for colds (perennial).

Lavender (*Lavandula vera*). Used for pleasant fragrance; also used in medicine (perennial).

Peppermint (*Mentha piperita*). Green or dried leaves used in soups, sauces, and for meats; also for flavoring puddings and gelatin desserts (perennial).

Rosemary (*Rosmarinus officinalis*). Aromatic leaves used for seasoning (perennial).

Sage (*Salvia officinalis*). Used for seasoning dressings and strong meats (perennial).

Spearmint (*Mentha spicata*). Green or dried leaves used in soups, sauces, and for meats; also for flavoring puddings and gelatin desserts (perennial).

Summer Savory (*Satureia hortensis*). Green parts used in flavoring meats and dressings (annual).

Sweet Marjoram (*Marjorana hortensis*). Leaves used in seasoning soups, meats, and dressings (annual or perennial).

Thyme (*Thymus vulgaris*). Used for flavoring soups, gravies, stews, sauces, and meats (perennial).

TABLE 62. VARIETY SUGGESTIONS COMPILED FROM RECOMMENDATIONS FOR THE SOUTHERN STATES

VEGETABLE	LEADING VARIETIES (LISTED ALPHABETICALLY)
Asparagus	Martha Washington, Mary Washington, Palmetto
Bean, bush lima	Burpee's, Fordhook, Henderson's, Jackson Wonder (Calico)
Bean, bush snap	Bountiful, Pencil Pod Wax, Red Valentine, Refugee (1,000 to 1), Stringless Green Pod, Tendergreen
Bean, pole lima	Florida Butter (Speckled), King of the Garden, Leviathan, Sieva (Small White)
Bean, pole snap	Kentucky Wonder, Mammoth Horticultural, McCaslan
Beet	Crosby's Egyptian, Detroit Dark Red, Eclipse, Extra Early Egyptian
Brussels sprouts	Improved Dwarf, Long Island Improved
Cabbage	Copenhagen Market, Flat Dutch, Glory of Enkhuizen, Golden Acre, Jersey Wakefield, Succession
Cantaloupe	Emerald Gem, Hale's Best, Hearts of Gold, Perfecto, Pollock 10–25
Carrot	Chantenay, Danvers Half Long, Early Scarlet Horn, Ox Heart
Cauliflower	Dry Weather, Dwarf Erfurt, Early Snowball
Celery	Giant Pascal, Golden Self-Blanching, Winter Queen
Celeriac	Giant Smooth Prague
Collard	Georgia or Southern, Louisiana Sweet
Corn (sweet)	Country Gentleman, Early Adams (not sweet), Golden Bantam, Stowell's Evergreen, Trucker's Favorite (not sweet), Whipple's Yellow
Cucumber	Davis Perfect, Early Fortune, Kirby (Stays Green), Long Green, White Spine
Eggplant	Black Beauty, New York Purple

TABLE 62. VARIETY SUGGESTIONS COMPILED FROM RECOMMENDATIONS FOR THE SOUTHERN STATES — *Continued*

VEGETABLE	LEADING VARIETIES (LISTED ALPHABETICALLY)
Irish potato . .	Bliss Triumph, Green Mountain (McCormick), Irish Cobbler, Lookout Mountain, Spalding No. 4
Kohl-rabi . . .	Early White Vienna
Leek	Large American Flag, London Flag
Lettuce	Big Boston, Grand Rapids, Hanson, May King, New York, Simpson
Mustard . . .	Fordhook Fancy, Southern Giant Curled
Okra	Dwarf Green, Dwarf Prolific, Kleckley's Favorite, White Velvet
Onion plants . .	Prizetaker, Yellow Bermuda
Onion seed . . .	Prizetaker, Yellow Bermuda, Yellow Globe Danvers
Onion sets . . .	Norfolk Queen, White Globe, White Pearl, Yellow Globe Danvers
Parsley	Double Curled, Triple Curled
Parsnip	Hollow Crown (Guernsey)
Pea (English) . .	Alaska, Alderman, Gradus, Laxtonian, Nott's Excelsior, Telephone, Thomas Laxton
Pepper	California Wonder, Chinese Giant, Long Red Cheyenne (hot), Ruby King, World Beater
Pumpkin . . .	Small Sugar (New England Pie), Striped Cushaw
Radish	China Rose, French Breakfast, Scarlet Globe, Scarlet Turnip, White Icicle
Rhubarb . . .	Linnaeus
Rutabaga . . .	Golden Neckless, Purple Top
Salsify	Long White French, Mammoth, Sandwich Island
Spinach	Bloomsdale Savoy, King of Denmark, Long Standing, New Zealand (not true spinach), Norfolk Savoy, Princess Juliana, Victoria, Viroflay
Squash, summer .	Early White Bush, Straight Neck, Summer Crook Neck
Squash, winter .	Delicious, Des Moines, Essex Hybrid, Fordhook, Hubbard
Swiss chard. . .	Giant Lucullus
Sweet potato . .	Nancy Hall, Porto Rico, Yellow Jersey
Tomato . . .	Bonny Best, Break O'Day, Chalk's Early Jewel, Earliana, Greater Baltimore, Gulf State Market, June Pink, Marglobe, Ponderosa, Pritchard, Stone
Turnip	Japanese Shogoin, Purple Top Milan, Seven Top, White Egg, White Globe
Watermelon . .	Dixie Queen, Kleckley Sweet, Irish Gray, Stone Mountain, Thurmond Gray, Tom Watson

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APPENDIX

Sources of Information

This text has a list of pertinent references at the end of each chapter. The names and addresses of several vegetable texts also appear at the end of Chapter 1.

Additional information can be obtained on vegetables and other subjects in mimeograph, circular, or bulletin form, without charge. Requests should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C., for a list of available publications of the United States Department of Agriculture.

The state experiment stations which are listed in Table A can supply many valuable publications on agricultural subjects, upon requests to the directors or mailing rooms.

TABLE A. STATE AGRICULTURAL EXPERIMENT STATIONS

State	Address	State	Address
Alabama	Auburn	Montana	Bozeman
Arizona	Tucson	Nebraska	Lincoln
Arkansas	Fayetteville	Nevada	Reno
California	Berkeley	New Hampshire	Durham
Colorado	Fort Collins	New Jersey	New Brunswick
Connecticut, State Station	New Haven	New Mexico	State College
Connecticut, Agr. College and Storrs Station	Storrs	New York, State Station	Geneva
Delaware	Newark	New York, Cornell Station	Ithaca
Florida	Gainesville	North Carolina	Raleigh
Georgia, Main Station	Experiment	North Dakota	Fargo
Georgia, Coastal Plains	Tifton	Ohio	Wooster
Idaho	Moscow	Oklahoma	Stillwater
Illinois	Urbana	Oregon	Corvallis
Indiana	La Fayette	Pennsylvania	State College
Iowa	Ames	Rhode Island	Kingston
Kansas	Manhattan	South Carolina	Clemson
Kentucky	Lexington	South Dakota	Brookings
Louisiana	Baton Rouge	Tennessee	Knoxville
Maine	Orono	Texas	College Station
Maryland	College Park	Utah	Logan
Massachusetts	Amherst	Vermont	Burlington
Michigan	East Lansing	Virginia, Main Station	Blacksburg
Minnesota	Saint Paul	Virginia, Truck Station	Norfolk
Mississippi	State College	Washington	Pullman
Missouri, College Station	Columbia	West Virginia	Morgantown
Missouri, Fruit Station	Mountain Grove	Wisconsin	Madison
		Wyoming	Laramie

Vitamins in Vegetables

Vegetables have long been valued for their health-giving qualities. Certain vegetables are rich sources of the minerals needed for body building and body regulating; some vegetables are good sources of fats, proteins, and carbohydrates; certain vegetables possess laxative qualities; and certain other vegetables are rich sources of the vitamins.

The vitamins are substances occurring in foods which are essential for growth, for reproduction, and for the maintenance of health.

It was in the effort to find the cause of the disease beriberi that the vitamin B_1 was discovered. In 1912, Funk named this class of essential dietary factors vitamins. Today, six vitamins are known: A, B (B_1), C, D, E, and G (B_2). "Each vitamin is entirely specific, in the sense that no one or combination of them can take the place of any other one."[2]

Vitamin A is essential for growth of the young, for reproduction, and for prevention of the eye disease, xerophthalmia. "Populations deprived of vitamin A have a high death rate due to infections of the lungs and intestines."[3]

Vitamin B is essential to the prevention of the disease beriberi, for the maintenance of a normal appetite, for infant nutrition, and for milk secretion.

Vitamin C is essential for healthy gums and for the prevention of the disease scurvy.

Vitamin D is required for correct utilization of calcium salts and phosphates in the nutrition of the growing and adult skeleton, and for prevention of rickets, osteomalacia, and dental diseases.

Vitamin E is essential for reproduction in animals. "There is as yet no clinical proof as to whether or not vitamin E is required by human beings."[4]

Vitamin G (B_2) is essential for the prevention of the disease pellagra, and for the growth of the young.

[1] Prepared by Isabella C. Wilson, Head Home Economics Department, College of Agriculture, University of Arkansas.

[2] Sherman, Henry C.: *Food and Health*, Macmillan, 1933, p. 107.

[3] Interim Report of the Mixed Committee of the League of Nations: *The Problem of Nutrition*, Vol. I, League of Nations, Geneva, Switzerland, 1936, p. 33.

[4] Rose, Mary Swartz: *Foundations of Nutrition*, Macmillan, 1933, p. 358.

Table B. Vegetables as Sources of Vitamins A, B, C, and G[1]

Vegetable	Vitamin A	Vitamin B	Vitamin C	Vitamin G
Asparagus	variable	*	++	*
Bean, kidney, dry or canned	+	*	*	+
Bean, soy	+	++	*	*
Bean, string	++	++	++	++
Beet, roots	+	+	+	+
Broccoli	++	++	+	++
Cabbage, head, raw	+	++	+++	++
Carrot	+++	++	++	++
Cauliflower	+	++	+	++
Celery, bleached stems	− to +	++	++	*
Chard	++	+ to ++	*	*
Collard	+++	++	++	++
Corn, white	+	++	−	+
Corn, yellow	++	++	−	+
Cowpea, dried	++	*	*	*
Cowpea, cooked	*	++	*	*
Cucumber	− to +	+	++*	*
Eggplant	+	+	+	*
Kale	+++	+	++	+++
Kohl-rabi	*	+	+	*
Lettuce	+ to ++	++	++	++
Okra	++	++	*	*
Onion, raw	− to +	+	++	+
Parsley	+++	++	+++	*
Parsnip	− to +	++	*	*
Pea, English, green	++	++	+++	+
Pea, English, dry	+	++	*	++
Pepper, green	++	++	+++	*
Potato, white	+	++	++	++
Pumpkin	++	+	+	+
Radish	− to +	++	++	*
Spinach	+++	+	++	++
Squash, Hubbard	+++	+	*	+
Sweet potato	+++	++	++	+
Tomato, raw or canned	++	++	+++	+
Turnip	− to +	+	++	+
Turnip greens	+++	++	+++	++

* Indicates that the evidence is lacking or appears insufficient.
− Indicates that the food furnishes no appreciable amount of the vitamin.
\+ Indicates that the vegetable contains the vitamin.
++ Indicates that the vegetable is a good source of the vitamin.
+++ Indicates that the vegetable is an excellent source of the vitamin.

[1] The above table was compiled from pages 597–601, Sherman, Henry C., *Chemistry of Food and Nutrition*, The Macmillan Company, N. Y., 1937; and from pages 152–155, Sure, Barnett, *The Vitamins in Health and Diseases*, Williams and Wilkins, 1933; by Isabella C. Wilson, Head, Home Economics Department, College of Agriculture, Univ. of Ark.

Table C. Composition of Vegetables (in Per Cent) [1]

	Water	Ash	Carbohydrates	Fat	Protein	Calories per Pound
Asparagus	94.0	.7	3.3	.2	1.8	101
Bean, Lima	68.5	1.7	22.0	.7	7.1	557
Bean, string	89.2	.8	7.4	.3	2.3	189
Bean, soy	6.1	5.2	26.6	20.7	39.4	—
Beet	87.5	1.1	9.7	.1	1.6	209
Cabbage	91.5	1.0	5.6	.3	1.6	143
Carrot	88.2	1.0	9.3	.4	1.1	205
Cauliflower	92.3	.7	4.7	.5	1.8	138
Celery	94.5	1.0	3.3	.1	1.1	84
Collard	87.1	1.5	6.3	.6	4.5	225
Corn	75.4	.7	19.7	1.1	3.1	459
Cucumber	95.4	.5	3.1	.2	.8	80
Eggplant	92.9	.5	5.1	.3	1.2	130
Greens, turnip	86.7	2.2	6.3	.6	4.2	220
Lettuce	94.7	.9	2.9	.3	1.2	87
Okra	90.2	.6	7.4	.2	1.6	175
Onion	87.6	.6	9.9	.3	1.6	220
Parsnip	83.0	1.4	13.5	.5	1.6	294
Pea, green	74.6	1.0	16.9	.5	7.0	454
Potato, white	78.3	1.0	18.4	.1	2.2	378
Spinach	92.3	2.1	3.2	.3	2.1	109
Squash	88.3	.8	9.0	.5	1.4	209
Sweet potato	69.0	1.1	27.4	.7	1.8	558
Tomato	94.3	.5	3.9	.4	.9	104
Turnip	89.6	.8	8.1	.2	1.3	178

[1] Tenn. Agr. Ext. Ser. Pub. 137, 1935.

Table D. Average Mean Temperature, Rainfall, Last Spring Frost, First Fall Frost, and Growing Season[1]

	Number of Years Averaged	Mean Annual Temperature in Degrees F.	Average Annual Rainfall in Inches	Average Date of Last Killing Frost in Spring	Average Date of First Killing Frost in Fall	Average Growing Season in Days
Alabama						
Birmingham	35	63.6	52.9	Mar. 19	Nov. 10	236
Mobile	59	67.4	62.0	Feb. 17	Dec. 7	293
Union Springs	44	64.9	50.7	Mar. 13	Nov. 17	249
Arkansas						
Fayetteville	39	58.7	44.4	Apr. 7	Oct. 23	199
Fort Smith	49	61.4	38.8	Mar. 21	Nov. 6	230
Hope	24	64.3	51.4	Mar. 20	Nov. 8	233
Little Rock	51	62.1	48.0	Mar. 17	Nov. 14	241
Florida						
Apalachicola	27	68.8	57.1	Feb. 11	Dec. 11	303
Avon Park	32	72.9	52.3	—	—	Practically all year
Jacksonville	59	69.2	50.5	Feb. 16	Dec. 7	294
Tampa	80	72.1	50.0	—	—	Practically all year
Georgia						
Atlanta	52	61.3	48.6	Mar. 29	Nov. 8	224
Augusta	85	61.6	45.5	Mar. 20	Nov. 11	236
Macon	33	64.3	45.7	Mar. 19	Nov. 10	236
Savannah	57	66.8	49.6	Mar. 1	Nov. 25	269
Thomasville	48	67.5	52.9	Mar. 10	Nov. 16	251
Kentucky						
Bowling Green	35	58.5	48.8	Apr. 14	Oct. 21	190
Louisville	58	57.0	43.5	Apr. 11	Oct. 22	194
Louisiana						
Alexandria	37	67.0	56.4	Mar. 11	Nov. 13	247
New Orleans	60	69.4	57.3	Feb. 18	Dec. 5	259
Shreveport	59	65.8	44.0	Mar. 7	Nov. 14	251
Mississippi						
Crystal Springs	39	65.0	55.1	Mar. 20	Nov. 8	233
Greenwood	33	64.2	53.1	Mar. 21	Nov. 6	230
Jackson	40	65.7	51.5	Mar. 18	Nov. 7	234
North Carolina						
Asheville	28	55.1	40.4	Apr. 11	Oct. 21	195
Charlotte	52	60.3	46.5	Mar. 25	Nov. 5	225
Raleigh	44	60.0	46.1	Mar. 27	Nov. 5	223
Wilmington	60	63.2	48.6	Mar. 21	Nov. 15	239
Oklahoma						
Oklahoma City	40	59.7	31.6	Mar. 29	Nov. 4	220
Durant	30	63.0	39.7	Mar. 21	Nov. 11	235

[1] Prepared by H. S. Cole, Meteorologist, U. S. Dept. Agr., Little Rock, Arkansas.

Table D. Average Mean Temperature, Rainfall, Last Spring Frost, First Fall Frost, and Growing Season — *Continued*

	Number of Years Averaged	Mean Annual Temperature in Degrees F.	Average Annual Rainfall in Inches	Average Date of Last Killing Frost in Spring	Average Date of First Killing Frost in Fall	Average Growing Season in Days
South Carolina						
Charleston . .	60	66.1	47.3	Feb. 20	Dec. 11	294
Columbia . .	56	63.6	43.9	Mar. 17	Nov. 18	246
Greenville . .	47	59.6	53.4	Mar. 30	Nov. 6	221
Tennessee						
Chattanooga .	52	60.4	51.0	Apr. 2	Oct. 26	207
Knoxville . .	60	58.2	48.2	Apr. 2	Oct. 29	210
Memphis . .	60	61.7	48.3	Mar. 21	Nov. 4	228
Nashville . .	60	59.4	47.1	Mar. 31	Oct. 28	211
Texas						
Amarillo . .	39	56.5	21.6	Apr. 17	Oct. 31	197
Brownsville .	70	73.2	27.2	Jan. 25	Dec. 23	332
Corpus Christi	44	70.7	25.4	Jan. 24	Dec. 27	337
Del Rio . . .	25	69.2	18.6	Feb. 23	Nov. 27	277
El Paso . . .	51	63.6	8.9	Mar. 19	Nov. 14	241
Fort Worth .	33	65.4	32.7	Mar. 11	Nov. 17	251
Palestine . .	49	66.0	40.7	Mar. 8	Nov. 18	255
San Antonio .	45	69.0	27.4	Feb. 23	Nov. 30	280
Virginia						
Lynchburg . .	59	57.0	40.4	Apr. 8	Oct. 27	202
Norfolk . . .	60	59.5	45.2	Mar. 24	Nov. 16	237
Richmond . .	51	58.2	41.5	Mar. 31	Nov. 2	216
Wytheville . .	28	52.4	39.4	Apr. 18	Oct. 15	180

Table E. Approximate or Average Weights of Vegetable Units[1]

Vegetable	Usual Unit of Pack	Net Weight in Pounds	Containers or Specifications	Approximate Number of Containers (Units) per Carload
Asparagus . .	Crate	24	$10\frac{1}{2}$ by ($9\frac{1}{2}$–11) by $17\frac{11}{16}$	460
Bean, lima . .	Bushel	32	Hampers or baskets	500
Bean, snap . .	Bushel	30	Hampers or baskets	530
Beet, table . .	Bushel	52	Hampers or baskets	500
Cabbage . . .	$1\frac{1}{2}$ bushel hamper	50	$1\frac{1}{2}$ bushel hamper	450
Cabbage . . .	Western lettuce crate	80	13 by 18 by $21\frac{3}{4}$	320
Cantaloupe . .	Standard 45 crate	60	12 by 12 by $22\frac{1}{2}$	360
Cantaloupe . .	Standard flat	25	$4\frac{1}{2}$ by $13\frac{1}{2}$ by $22\frac{1}{2}$	720
Carrot . . .	Bushel	50	Hamper or basket	550
Cauliflower . .	Crate	39	$8\frac{1}{2}$ by 18 by $23\frac{1}{4}$	500
Celery . . .	$\frac{3}{4}$ crate (Florida)	90	22 or 24 by 10 by 20	350
Corn, sweet .	Bushel	35	(Sacks and crates also used)	500
Cucumber . .	Bushel	48	Hampers or baskets	400
Eggplant . .	Bushel	33	Crates, hampers, baskets	550
Kale	Bushel	18	(Barrels also used)	—
Lettuce . . .	Western lettuce crate	75	13 by 18 by $21\frac{3}{4}$	320
Onion . . .	Bushel	54	(Baskets, crates, and sacks also used)	500
Pea	Bushel	30	(Baskets, hampers, and crates also used)	520
Pepper . . .	Bushel	25	Baskets, hampers, and crates	500
Potato, Irish .	Bushel	60	(Shipped in barrels, hampers, etc.)	500
Potato, Irish .	Sacks	100	Variable size sacks	250
Potato, sweet .	Bushel (Harvest wt.)	55	Baskets, hampers, and crates	500
Spinach . . .	Bushel	18	(Hampers, crates, and barrels also used)	750
Tomato . . .	Lug box	31	$4\frac{1}{2}$ by ($11\frac{1}{2}$–$13\frac{1}{2}$) by $20\frac{5}{16}$	800
Turnip . . .	Bushel	54	Crates, sacks, and baskets	—

[1] Prepared by W. R. Stark from revised list of *Approximate or Average Weights of Various Commodities* and *Table of Number of Packages per Carload*, U. S. Dept. Agr., B. A. E., Mimeographs, May, 1936, and January, 1933, respectively.

(The above figures are only approximates. Specifications and weights of containers, method of packing, and number of units per carload vary greatly from section to section.)

TABLE F. APPROXIMATE ACREAGE OF VEGETABLES NECESSARY FOR CARLOT SHIPMENTS [1]

Vegetable	Acreage	Vegetable	Acreage
Asparagus	150	Okra	60
Beet	7	Onion	4
Cabbage	3	Pea	17
Cantaloupe	40	Pepper	5
Carrot	8	Radish	8
Celery	2	Snap bean	14
Collard	3	Spinach	4
Cucumber	15	Squash	14
Eggplant	18	Sweet corn	12
Irish potato	6	Sweet potato	6
Kale	4	Tomato	17
Lettuce	4	Turnip	6
Mustard	5	Watermelon	7

L. A. Niven, Progressive Farmer and Southern Ruralist.

[1] Averages only approximate and will vary greatly under different conditions. The time factor of loading a car, with or without refrigeration, depending on the perishability of the product; daily acre yield and total acre yield; and season or maturity of the crop are factors considered.

GLOSSARY[1]

Allelomorph. One of a pair of contrasting unit characters.

Alluvial. Stream-laid deposits.

Anaerobic. Pertaining to bacteria or other organisms which flourish without free oxygen.

Angiosperm. Any plant of the class having the seed in a closed ovary.

Anther. The pollen-bearing part of a stamen.

Anthesis. The time or process of expansion in a flower.

Axil. The angle formed by a leaf or branch with the stem.

Axis. The central line of any organ or support of a group of organs; a stem, etc.

Biennial. Living for two years under normal, outdoor conditions, usually producing seed the second year.

Buffer. Materials which prevent sudden changes in acidity.

Bulb. A subterranean leaf-bud with fleshy scales or coats.

Calyx. The outer perianth of the flower.

Cankers. Localized lesions on stems which generally result in the corrosion and sloughing away of tissue with the final production of an open wound, exposing or penetrating the wood.

Carbohydrate. Any group of organic compounds composed of carbon, hydrogen, and oxygen.

Catalytic. Pertaining to chemical action in which the speed of the reaction is hastened or retarded by a substance which does not enter into the end products.

Cellulose. A shapeless white compound, insoluble in all ordinary solvents, forming the fundamental material of the structure of the plants.

Chlorophyll. The green coloring matter of plants.

Chloroplast. A plastid containing chlorophyll, developed in cells exposed to light.

Chlorotic. Lack of chlorophyll, giving the plants a blanched appearance.

Chromosomes. A number of well-individualized units, in the nucleus, each of which in turn has a characteristic organization.

Clove. One of a group of small bulbs produced by the garlic plant.

Colloids. Uncrystalline materials, often gelatinous, which diffuse slowly or not at all.

Connate. Born or originated together; agreeing in nature.

Corm. The enlarged fleshy base of a stem, bulblike but solid.

Corolla. The inner perianth of distinct or connate petals.

Cotyledon. A seed leaf or first leaf of an embryo.

Cuticle. A continuous layer of structureless, waxy substance which covers the aerial parts of vascular plants except the growing points.

[1] Prepared by V. M. Watts, Associate Professor of Horticulture, Ark. Exp. Sta., and R. S. Woodward, Technical Asst., U. of A. Fruit and Truck Br. Exp. Sta.

Cutin. A waxy substance which covers most of the aerial parts of vascular plants.

Cytoplasm. A more or less transparent, viscous fluid constituting all of the protoplasm except the nucleus.

Decompound. More than once compound or divided.

Dextrin. A shapeless, brownish-white carbohydrate substance.

Dibble. Instrument for making holes in which to insert plants or bulbs.

Dicotyledonous. Having two cotyledons.

Diffusion. The passage of molecules or ions in solution from one part of the solution to another, especially through a membrane.

Dihybrid. A cross which involves two character differences.

Dioecious. Unisexual, with the male and female flowers on separate plants.

Dominant. A parental character which has the ability to express itself in the resulting hybrid offspring.

Emasculation. Removing the stamens.

Embryo. An organism in the early stages of development, as before hatching from an egg, or sprouting from a seed.

Endodermis. A sheath composed of one or more layers of modified parenchymatous cells, which encloses certain fibrovascular bundles.

Endosperm. The stored food supply in a seed.

Exosmosis. The diffusion of solvent or solute outward from the cell vacuole.

Family. A division of an order. Usually a family comprises two or more genera, but one genus possessing sufficiently distinctive characters may form a family.

Flora. The aggregate of plants growing without cultivation in a country or district, or indigenous to a particular geological formation; as, a desert flora.

Floret. A small flower, usually one of a dense cluster.

Foliar. Of, pertaining to, consisting of, or resembling leaves.

Formalin. An aqueous solution of formaldehyde; a trade name.

Fungicides. Anything that kills fungi or destroys their germs.

Gene. That portion of the chromosome which serves to transmit characters from parents to progeny.

Genotype. The constitution of an organism with respect to factors of which it is made up; the sum of all genes.

Genus. A classificatory group of animals or plants embracing one or more species.

Herb. A plant with no persistent woody stem above the ground.

Hermaphroditic. Being of both sexes.

Homologous. Alike, similar, or same.

Hybrid. The offspring of plants or animals of different genotypes, varieties, species, or genera.

Hybridization. The practice of crossing between genotypes.

Indehiscent. Not opening by valves, etc.; remaining persistently closed.

Inflorescence. General arrangement and disposition of flowers on an axis; flower cluster.

Inoculation. The process of improving soils by the introduction of special microorganisms.

Insecticide. A substance used to destroy or to repel insects.

Internode. The portion of a stem between two nodes or joints.

Keel. The two anterior united petals of a butterflylike flower, such as a bean flower.

Lignin. A substance related to cellulose, which with it constitutes the essential part of woody tissue.

Longevity. Length or duration of life.

Molecule. A unit of matter, the smallest portion of an element or compound which retains identity in character with the substance in mass.

Monocotyledon. Having only one cotyledon.

Monoecious. Having both sexes on the same plant.

Mosaic. Diseases characterized by mottling of the plant due to spots of light green or yellow or dark green.

Mulches. Any substance, as straw, used to protect roots of plants from heat, cold, or drought, or to keep fruit clean.

Mutation. An hereditary change in the character of an organism.

Mycelium. The vegetative body of a fungus composed of threads.

Necrosis. A disease causing plant tissue to turn black and decay.

Nodule. A knot, lump, or node on the roots of plants.

Nucleus. The more or less centrally situated organ of the cell containing the chromatin, known as the hereditary substance.

Osmosis. Passage of the solvent from one side of a membrane to another where the escaping tendency of the solvent on the two sides is unequal.

Ovary. In angiosperms, an enlarged portion of the pistil, containing ovules.

Panicle. A loose irregularly compound inflorescence with pedicellate flowers.

Parenchyma. The fundamental tissue, usually composed of thin walled cells, making up the bulk of the substance of the leaves, the pulp of fruit, the pith of stems, etc.

Pectin. A neutral substance occurring in many vegetable tissues as part of the sap or cell wall.

Peduncle. A flower stalk.

Perianth. The floral envelope, consisting of the calyx and corolla (when present) whatever their form.

Pericycle. A thin cylinder of tissue sheathing the vascular tissues.

Periderm. The cortical tissue derived from the phellogen (cork cambium).

Petiole. The stalk or stem of a leaf.

Phenotype. A type or strain of organisms distinguishable from others by some character, whether this character be due to heredity or environment.

Phloem. Part of the conducting tissue of plants, usually thought to be instrumental in the conduction of elaborated food.

Photosynthesis. Process of manufacturing food.

Pigment. A coloring matter, especially in the cell or tissue.

Pistil. The seed-bearing organ of a flower, consisting of the ovary, stigma, and style when present.

Pith. A roughly cylindrical body of tissue in the center of the axis, enclosed by the vascular tissues.

Plastid. A unit of protoplasm.

Plumule. The bud or growing point of the embryo.

Pollen. Dustlike male bodies capable of fertilization of ovules.

Pollinate. To transfer the pollen from the stamens to the pistils.

Progeny. The descendants of a single plant or pair of plants.

Propagate. To cause to multiply.

Protein. Any of several organic, nitrogenous compounds.

Protoplasm. The living substance within a cell.

Recessive. Pertaining to a character which is subordinate to or masked by an allelomorphic character.

Receptacle. The more or less expanded or produced portions of an axis which bears the organs of a flower or the collected flowers of a head.

Rogue (noun). An off-type plant or a diseased plant.

Rogue (verb). To remove off-type or diseased plants.

Sclerotium. A compact, waxy or horny mass of hyphal tissue found in certain higher fungi.

Seed. An embryonic plant with its surrounding integuments or coats.

Sepal. A leaf or division of the calyx.

Sheath. A tubular envelope, as in the lower part of the leaf in grasses.

Species. A classificatory group of plants or animals, subordinate to a genus, and having members that differ only slightly among themselves.

Sperm. A motile ciliated male reproductive cell.

Stamen. A pollen-bearing organ of a flower.

Stigma. The part of the pistil which receives the pollen in pollination.

Stipule. An appendage at the base of the petiole of a leaf.

Style. The extended portion of a pistil connecting stigma and ovary.

Suberin. A fatty or waxy substance characteristic of cork tissue.

Sucrose. A non-reducing sugar, the most common commercial form of which is cane or beet sugar, having the empirical formula $C_{12}H_{22}O_{11}$.

Tuber. A short thickened underground stem having numerous buds or eyes.

Umbel. A flower cluster in which the flower stalks spring from the same point, as in a wild carrot.

Unisexual. Of one sex; either male or female; not hermaphroditic.

Viability. Alive or ability to remain alive.

Virus. A group of materials acting poisonously, produced and increased within the plant.

Vitamins. A group of food substances other than fats, proteins, carbohydrates, and salts which are essential to normal nutrition and serve to prevent various diseases.

Volatile. Capable of rapid evaporation in air at ordinary temperatures.

Whorl. A group of organs arranged about a stem; arising from the same node.

Xylem. A part of the vascular bundle or conducting tissue.

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